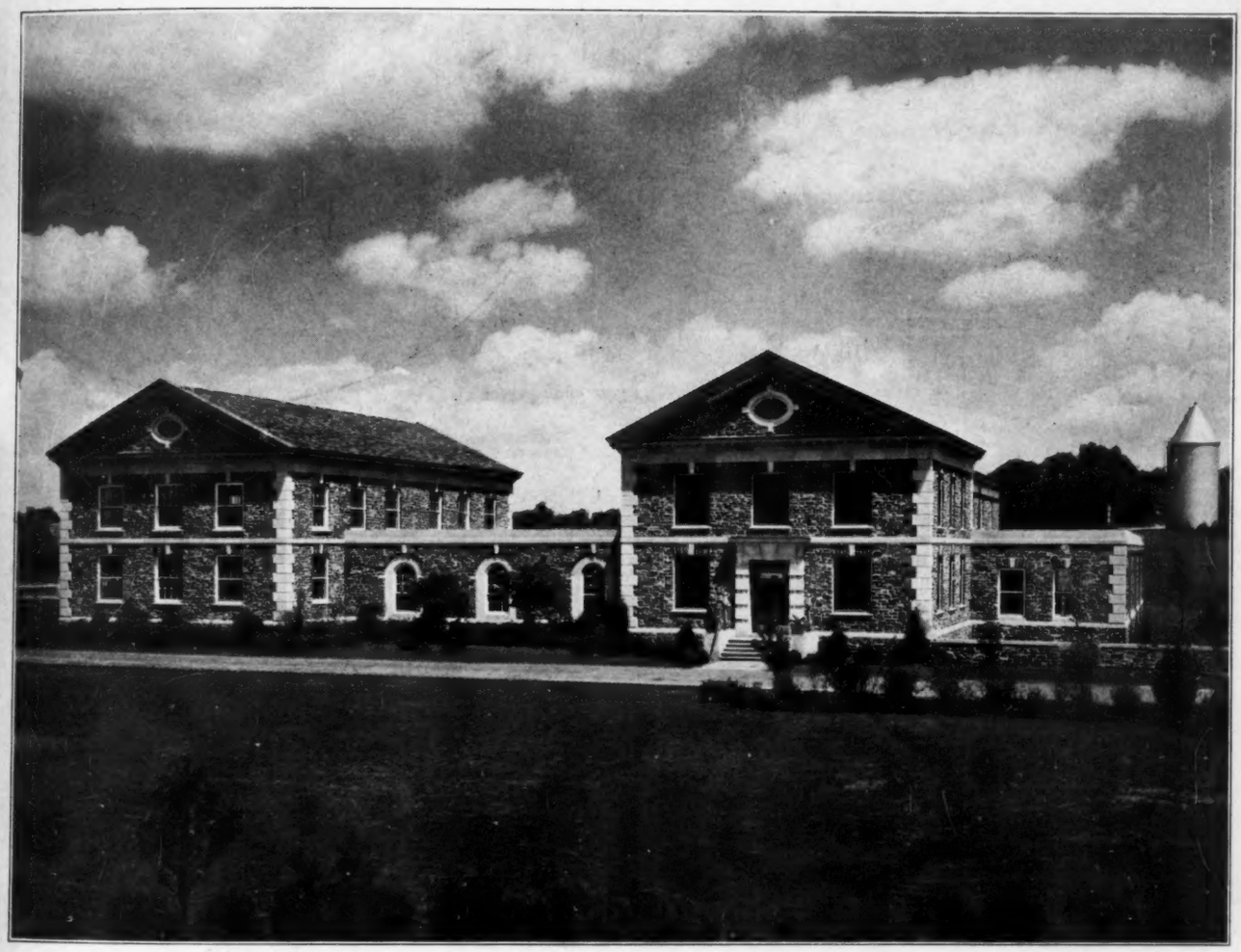
WATER WORKS AND SEWERAGE

ABC ABP A GILLETTE PUBLICATION

September, 1935 — Editor — Vol. LXXXII. No. 9



The Filtration Plant of Lancaster, Pa. (Designed by J. N. Chester Engineers—Operated by Jas. J. Malone, Supt. of Water Works)

IN THIS ISSUE

Spray Drying of Sludge

Meeting of Central States Section A.W.W.A.

Anthrafilt Gives Longer Filter Runs Than Sand

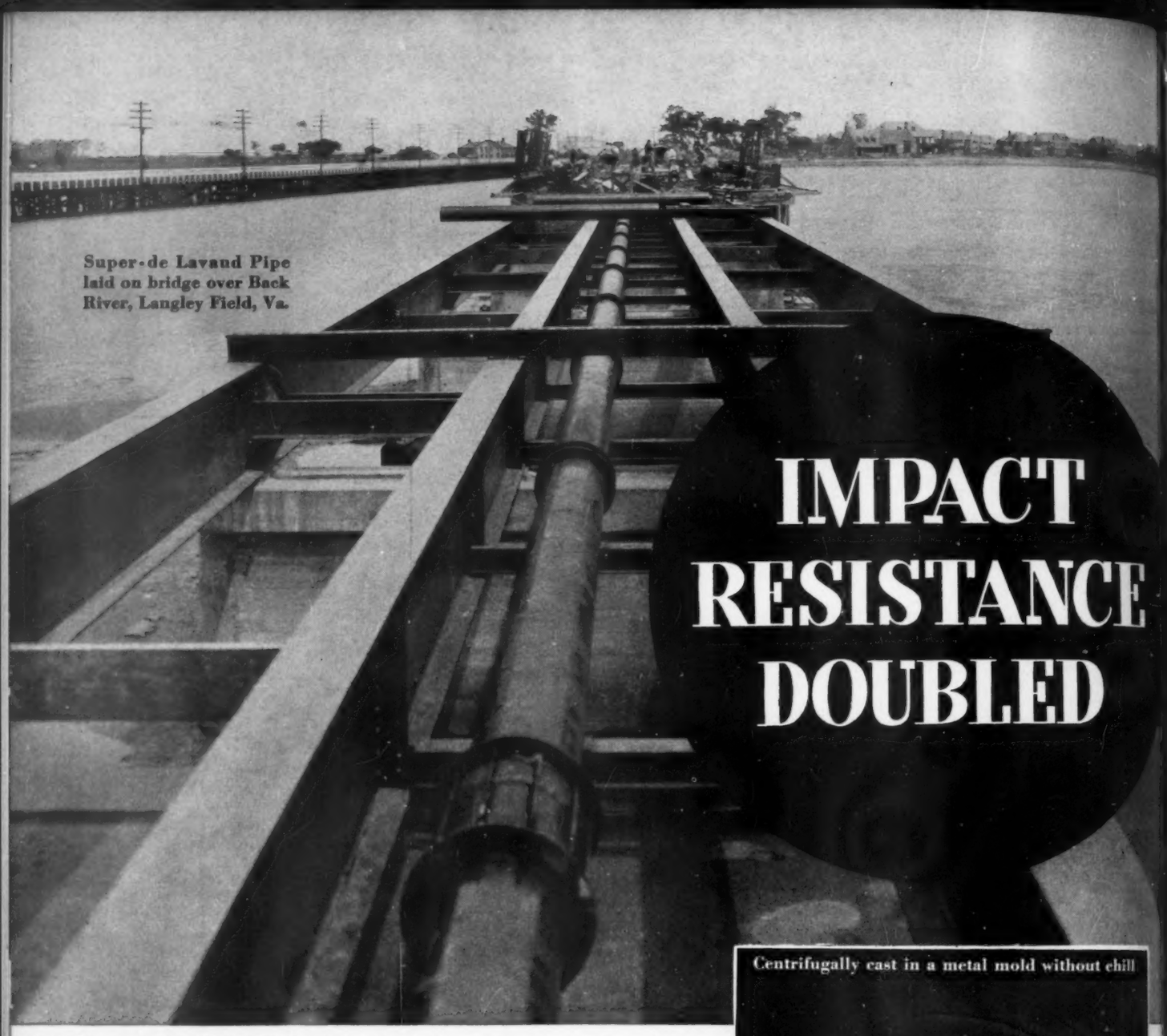
A Study of Filtering Materials for Rapid Sand Filters

The Chemical Sewage Treatment Plant of York, Nebr.

The Water Works of Lancaster, Pa., on Its One Hundredth Birthday

DESIGN · CONSTRUCTION · COLLECTION

TREATMENT · DISTRIBUTION · DISPOSAL



Super-de Lavaud Pipe laid on bridge over Back River, Langley Field, Va.

IMPACT RESISTANCE DOUBLED

Plain End Super-de Lavand Pipe with Couplings laid on bridge over Back River, Langley Field, Va.

CAST iron pipe made 270 years ago is still in service. Super-de Lavaud Pipe, in common with all good cast iron pipe made today, shares the heritage of longevity passed on by those early pipe founders. Three centuries of improvements have intervened. An important recent development, perfected and patented by this Company, is the Super-de Lavaud process of centrifugal casting of gray iron in a metal mold *without chill.* Pipe produced by this method, as evidenced by nearly 9 million feet sold and installed, has a fundamentally improved metal structure—stronger, tougher, more ductile. Impact resistance is more than doubled—tensile and bursting strength retained. Ask for descriptive booklet.

Centrifugally cast in a metal mold without chill

U.S. SUPER-de LAVAUD PIPE

CAST WITHOUT CHILL IN A METAL MOLD

UNITED STATES PIPE AND FOUNDRY CO., General Office: BURLINGTON, N. J.

Foundries and Sales Offices throughout the United States

WATER WORKS & SEWERAGE

L. H. ENSLOW,
Editor

FUTURE ARTICLES
To Appear in the Next and Subsequent Issues

"Elements of Water and Sewage Works Meters": L. D. Carlyon, M. E., Bailey Meter Company, Cleveland, O., constitutes a discussion of the fundamental principles, applications, and relative merits of the Venturi tubes, flow nozzles and orifices as applied to the measurement of water, air, sewage and sludges. To the novice the treatment of the subject is all new; to the experienced it has that value of being memory refreshing, and in several particulars, also entirely new.

"A Method of Clearing Choked Service Lines" which is to be described by S. H. Davis, Supt., Benwood and McMechen Water Company, Benwood, W. Va., has proved simple, economical and effective. It involves the use of a cylinder of compressed air which "shoots" a 2-foot slug of rock salt "buckshot" through an armored hose connected to the service line. The high pressure surge of the compressed air and scouring effect of the salt "shot" does the job of recovering the depreciated capacity of the service pipe.

"Sewerage Kinks": As recounted by A. M. Rawn, will supply useful information concerning special equipment and schemes, applied in the operation and maintenance of the sewerage systems of the Los Angeles County Sanitation Districts, of which the author is Assistant Chief Engineer.

"A Modern Engineering Office": Is the subject of a forthcoming article by N. T. Veatch, Jr., of Kansas City, Mo., who has agreed to describe the unique features of the modern offices of Black and Veatch, Engineers, in which especial considerations are given to the arrangement of lighting and ventilation systems. Likewise to other details productive of comfort and efficiency in the drafting rooms, laboratories and offices.

"Chlorination of Activated Sludge": By E. E. Smith, Supt. of Water Works and Sewerage, Lima, O., reveals experiences at the Lima Sewage Treatment Plant, wherein moderate chlorination of returned activated sludge controls undesirable filamentous biological growths in the aeration tanks. This, in turn, corrected sludge bulking and made possible worth while reductions in air requirements and operating costs with attendant increased dependability of the process.

"Forgotten Meters": Is the subject of an article by Earl A. Smith, a practical mechanic with a variety of experience in the field, and now Chief Meter Inspector for the Badger Meter Co. He discusses the care and maintenance of meters and gives suggestions of value in meter shop practice.

"A Marble Filter for Corrosive Waters": Which has proved a practical method of raising the pH of the well water to reduce pipe corrosion, will be described by Henry Ryon, Sanitary Engineer, New York Department of Public Works, who also cites operating results. Especially interesting is this scheme, for small and intermittently pumped supplies similar to that to which this installation was applied.

Vol. LXXXII, No. 9

CONTENTS for SEPTEMBER, 1935

The Water Works of Lancaster, Pa., on Its One Hundredth Birthday 297
By JAMES J. MALONE
Superintendent, Bureau of Water, Lancaster, Pa.

Spartanburg, S. C., Erects a 1,500,000-Gallon Elevated Storage Tank 303
By R. B. SIMMS and J. K. MARQUIS
Respectively Superintendent of Water Works and Sewerage; Engineer in Charge of Filtration and Pumping

The Sewage Treatment Works of York, Neb. 305
By F. M. VEATCH
With Black & Veatch, Consulting Engineers, Kansas City, Mo.

Anthrafilt Gives Longer Filter Runs Than Sand 308
By H. G. TURNER and G. S. SCOTT
Respectively Director and Former Assistant Director of Research for the Anthracite Institute, Pennsylvania State College, State College, Pa.

Meeting of the Central States Section A. W. W. A. 311

"Tegul": A New Sulphur Jointing Compound for Bell and Spigot Pipe 317
By C. R. PAYNE
Research Chemist, Atlas Mineral Products Co., Mertztown, Pa.

Operating Experiences at Newark, N. Y., Sewage Treatment Plant. 319
By THOMAS J. SMITH
Superintendent, Sewage Treatment Plant, Newark, N. Y.

Spray Drying of Sludge 323
By JOHN R. DOWNES
Superintendent Joint Sewage Treatment Works of Plainfield, N. J.

A Study of Filtering Materials for Rapid Sand Filters 326
By JOHN R. BAYLIS
Physical Chemist, Bureau of Public Works, Chicago, Ill.

Tannery Waste Disposal at Rockford, Mich. 331
By G. E. HUBBELL
Consulting Engineer, Detroit, Mich.

Inclined Diagonal Pipe Runs 333
By CHARLES FRICK

Editorial 334

New Equipment and Literature 335

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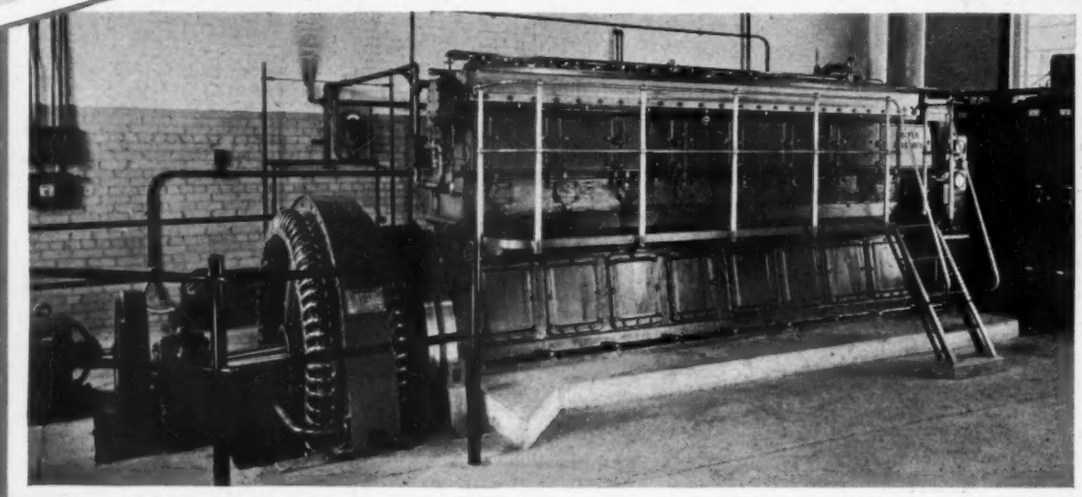
70% SAVED with modern Diesel

View of the Water-Works Plant of Gainesville, Texas, showing the eight-cylinder Type-JT Cooper-Bessemer Diesel, rated 375 H. P. at 327 r. p. m., driving a 250 K. W. electric generator.



HERE'S a Diesel that is returning to the City of Gainesville, Texas, seventy cents out of every dollar previously spent for water pumping costs.

This 375-H. P. Cooper-Bessemer Diesel engine has reduced the cost of lifting each thousand gallons of water, from two cents—the cost with the former steam engines—to *six mills*, or to 30% of the former cost!

For any power plant, from a mammoth oil refinery to the smallest ice-production plant, Cooper-Bessemer Diesels provide steady, efficient operation at a minimum of maintenance and operating costs.

THE COOPER-BESSEMER CORPORATION

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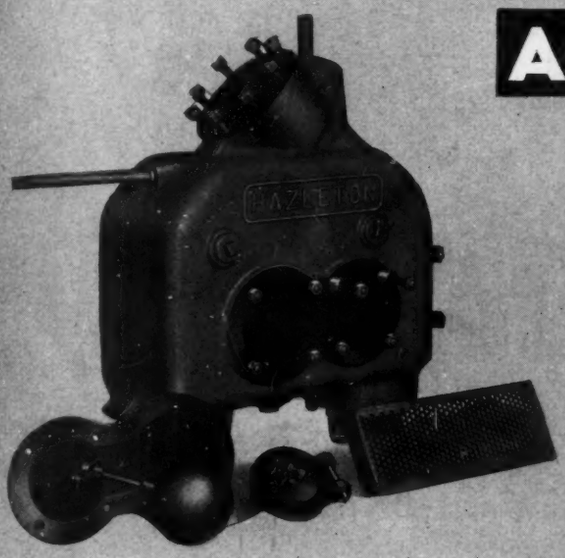
640 East 61st St. Los Angeles, Calif. | 201 East First St. Tulsa, Oklahoma | Magnolia Bldg Dallas, Texas | 25 West 43rd St. New York City | Mills Bldg. Washington, D. C. | 225 Crockett St. Shreveport, La. | Esperson Bldg. Houston, Texas

In addition to the line of vertical engines ranging from 35 to 1250 H. P. there is a new bulletin available covering a modern two cycle horizontal engine in sizes from 25 to 110 H. P. developed especially for the smaller power user.

HAZLETON

ACCESSORIES



THE SUCTION LINE PRIMER

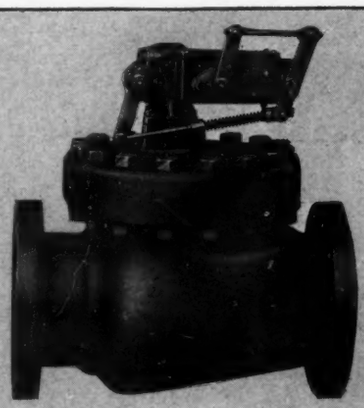
A self-priming device with check valve and strainer for single stage pumps, old or new, on heads up to 200 ft. The addition of a simple control panel provides complete automatic operation.

HEAVY DUTY CHECK VALVE

(Below) with finger-contact flow switch for severe service in and about the mines. Protects pump against damage due to loss of water.

TYPE "M" CHECK VALVE

(Below) with mercoid flow switch for general service where the ruggedness of the heavy duty valve is not necessary



ALSO—MOTOR DRIVEN PRIMING PUMPS, vacuum breakers, priming chambers, automatic priming valves, plug valves, automatic pumping panels and complete automatic pumping systems.

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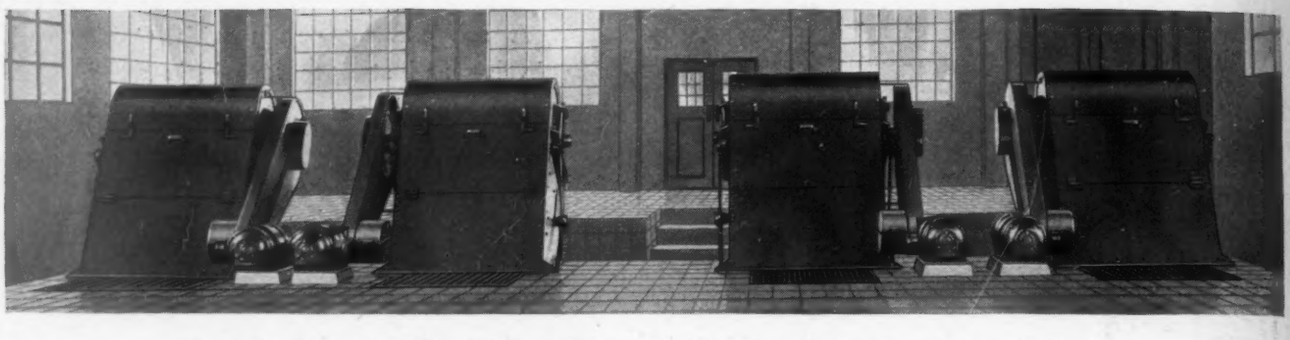
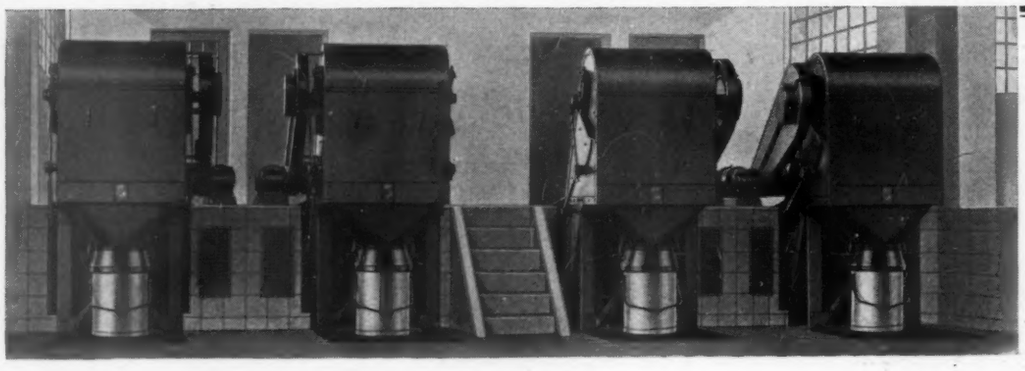
PREFERRED For a Completely Modern Plant

METROPOLITAN DISTRICT COMMISSION
HARTFORD, CONNECTICUT

INSTALLS 4 REX MECHANICALLY CLEANED BAR SCREENS



4 Rex Mechanically Cleaned Bar Screens—Metropolitan District Commission, Hartford, Connecticut. Note the neat appearance—the easy method of screenings disposal.



Because of their screening efficiency—convenience—low cost for installation, operation, and maintenance—time-tested and proved design—4 Rex Mechanically Cleaned Bar Screens were recently installed by the Metropolitan District Commission, Hartford, Connecticut.

Rex Bar Screens, Sludge Collectors and Sludge Pumps are products of a specialized division of the Chain Belt Company that dates back to 1917.

A NEW CATALOG

A new Catalog—No. 259—gives full details on the advantages of Rex Mechanically Cleaned Bar Screens—and their application. You will find it useful in your work—send for your copy.

CHAIN BELT COMPANY, 1610 W. Bruce St., Milwaukee, Wis.

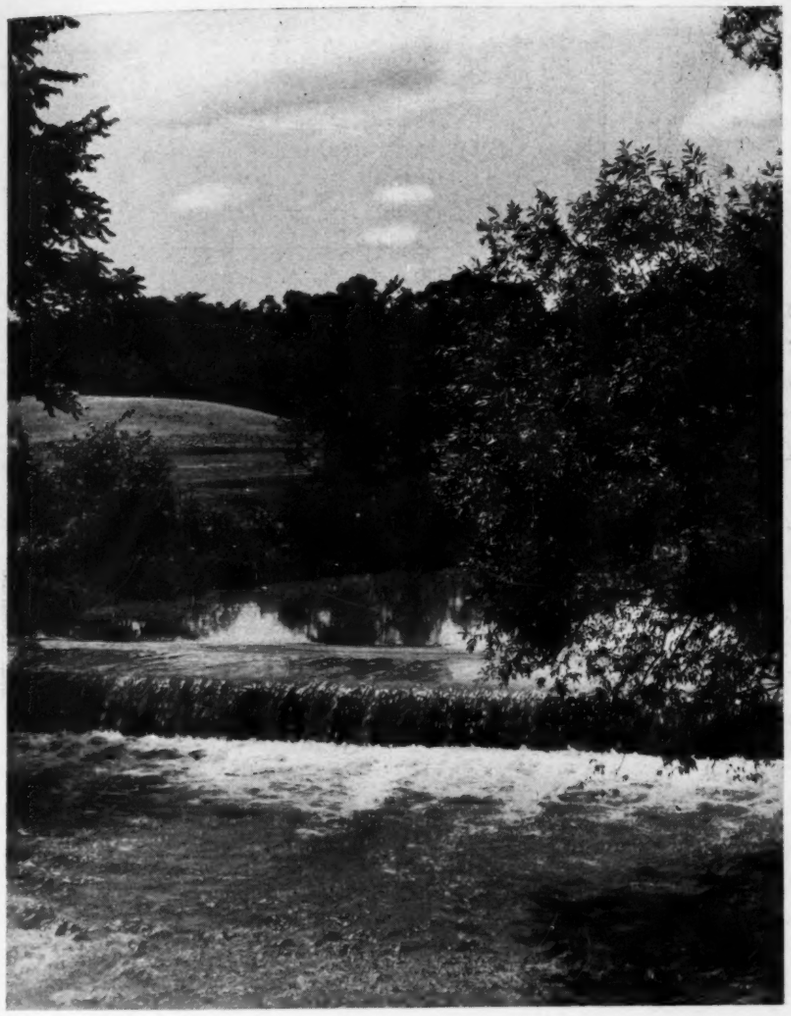
SEWAGE • TRADE WASTES • WATER TREATMENT • SLUDGE REMOVERS • SCREENS • SLUDGE PUMPS

Established 1891—Branches or Representatives in all Principal Cities

CHAIN BELT COMPANY

REX **SANITATION EQUIPMENT**

"IN TIME OF PEACE



Prepare FOR WAR"

THIS peaceful stream may soon be the source of taste and odor troubles.

Prepare in advance by having sufficient AQUA NUCHAR on hand to combat these conditions that will surely arise.

Your consumers and taxpayers will appreciate this service—your "good will relationship" will be assured.

NUCHAR

STOCKS CARRIED IN ALL OF THE LEADING CITIES THROUGHOUT UNITED STATES AND CANADA.

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When a man signs his name

● On a recent visit of 700 contractors to the Crane CORWITH Works, Chicago, amazement was expressed on all sides at the elaborate system of inspection, gauging and testing which controlled the manufacture of every elbow, tee, union, nipple, valve and faucet.

When a man signs his name, he is laying bare his character for the whole world to see and to appraise. When Crane Co. sends even a ¼" nipple out of the factory, that nipple must be a flawless product, a symbol of its maker's integrity. On this principle every Crane product and service is made and sold.

Your steam and water lines fabricated with Crane products, you have an integrated piping system whose dependability and long life is guaranteed by the character of Crane manufacture and Crane Co. responsibility.

With stocks in all leading cities, and a service organization equipped and eager to serve every industrial need, Crane Co. suggests that you enlist its aid in bringing your plant up to the profit-level of efficiency and reduced maintenance cost.

CRANE SHOP FABRICATION SERVICE

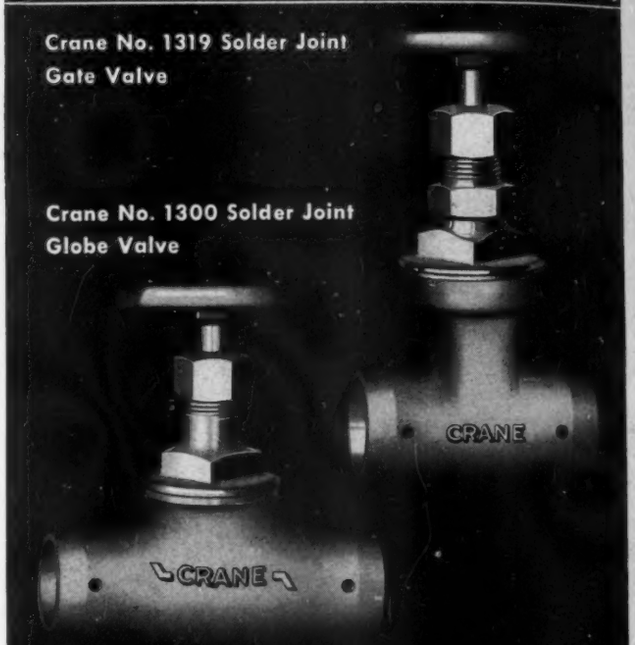
Design — Flanging
Casting — Cutting
Bending — Threading
Welding — Assembling

There is a Crane Valve or Fitting for every piping requirement

FOR SOLDERING

Crane No. 1319 Solder Joint Gate Valve

Crane No. 1300 Solder Joint Globe Valve



Crane Solder Joint Valves

1 Crane introduces a new and complete line of brass valves with ends for solder joint.

2 The solder joint ends are accurately machined for use with copper tubing and are designed in accordance with the patents of the Mueller Brass Co., Streamline Division.

3 These valves are built to established Crane standards, all parts being interchangeable with companion lines of screwed end valves.

4 Crane Solder Joint Fittings also now available in a wide range of types and sizes.

CRANE VALVES, FITTINGS and PIPE FABRICATION

CRANE CO., GENERAL OFFICES: 836 SO. MICHIGAN AVE., CHICAGO, ILL. • NEW YORK: 23 W. 44TH STREET

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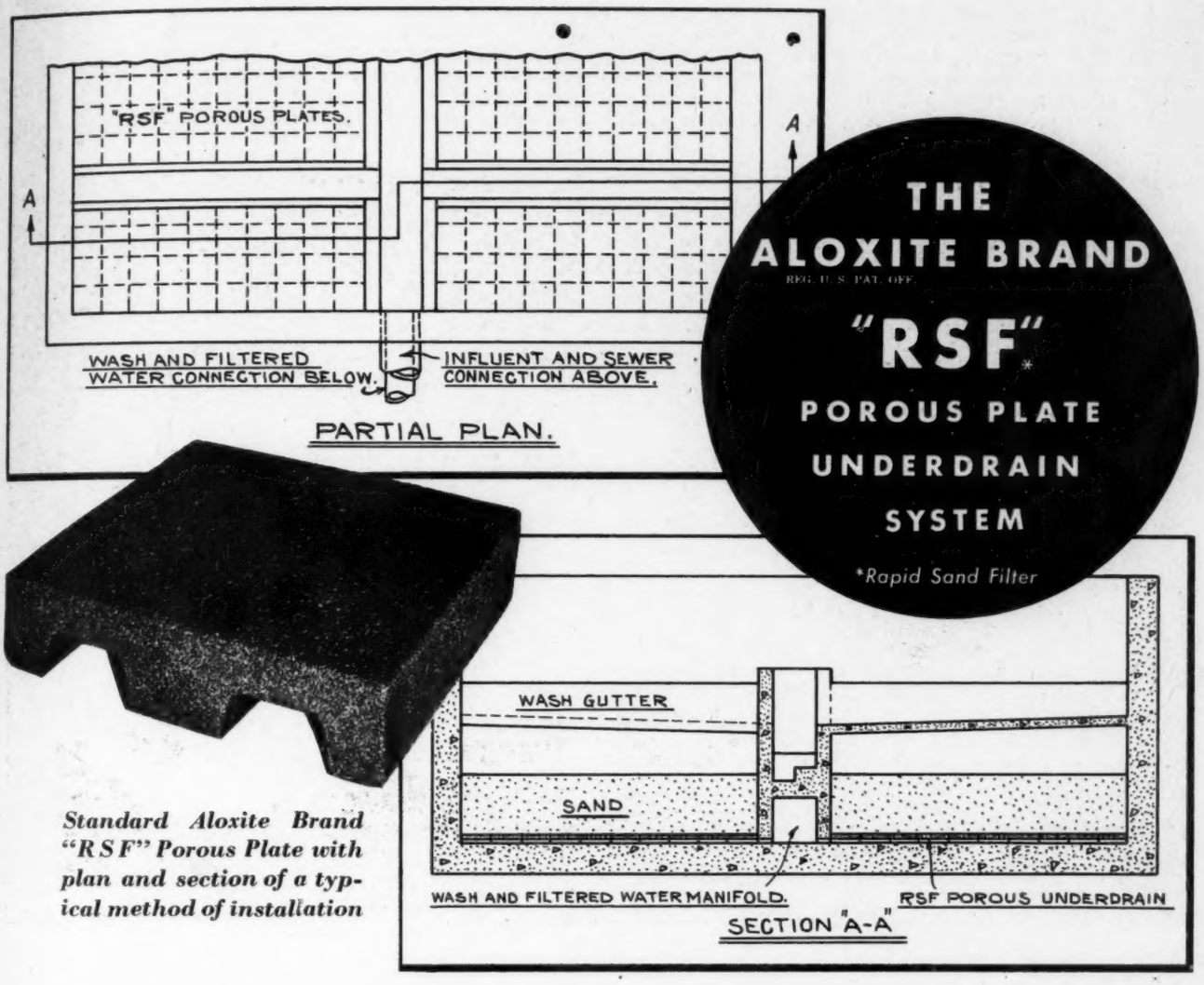
WATERWORKS ENGINEERS *agree that here is a much needed improvement . . .*



Standard Aloxite Brand "R S F" Porous Plate with plan and section of a typical method of installation

THE ink was hardly dry on our first announcement of this improved system before hundreds of interested Engineers and Waterworks Superintendents inquired for complete details.

The flood of inquiries definitely showed the need for this new underdrain system—the most outstanding improvement in filter design in recent years.

The new underdrain system employing Aloxite Brand "R S F" Porous Plates offers these distinct advantages:

- Uniformity of backwash.
- Permanent protection against disruption of sand bed.
- Elimination of gravel layers.
- A chemically inert filter bottom.
- Plates bonded directly to filter floor—no ridges or holding down bolts.
- Reduced operating heads, both filtering and backwashing.
- Air wash without auxiliary equipment.

Our sanitary engineers will gladly discuss this new system with you

THE CARBORUNDUM COMPANY

REG. U. S. PAT. OFF.

NIAGARA FALLS, N. Y. CANADIAN CARBORUNDUM CO., LTD., NIAGARA FALLS, ONT.

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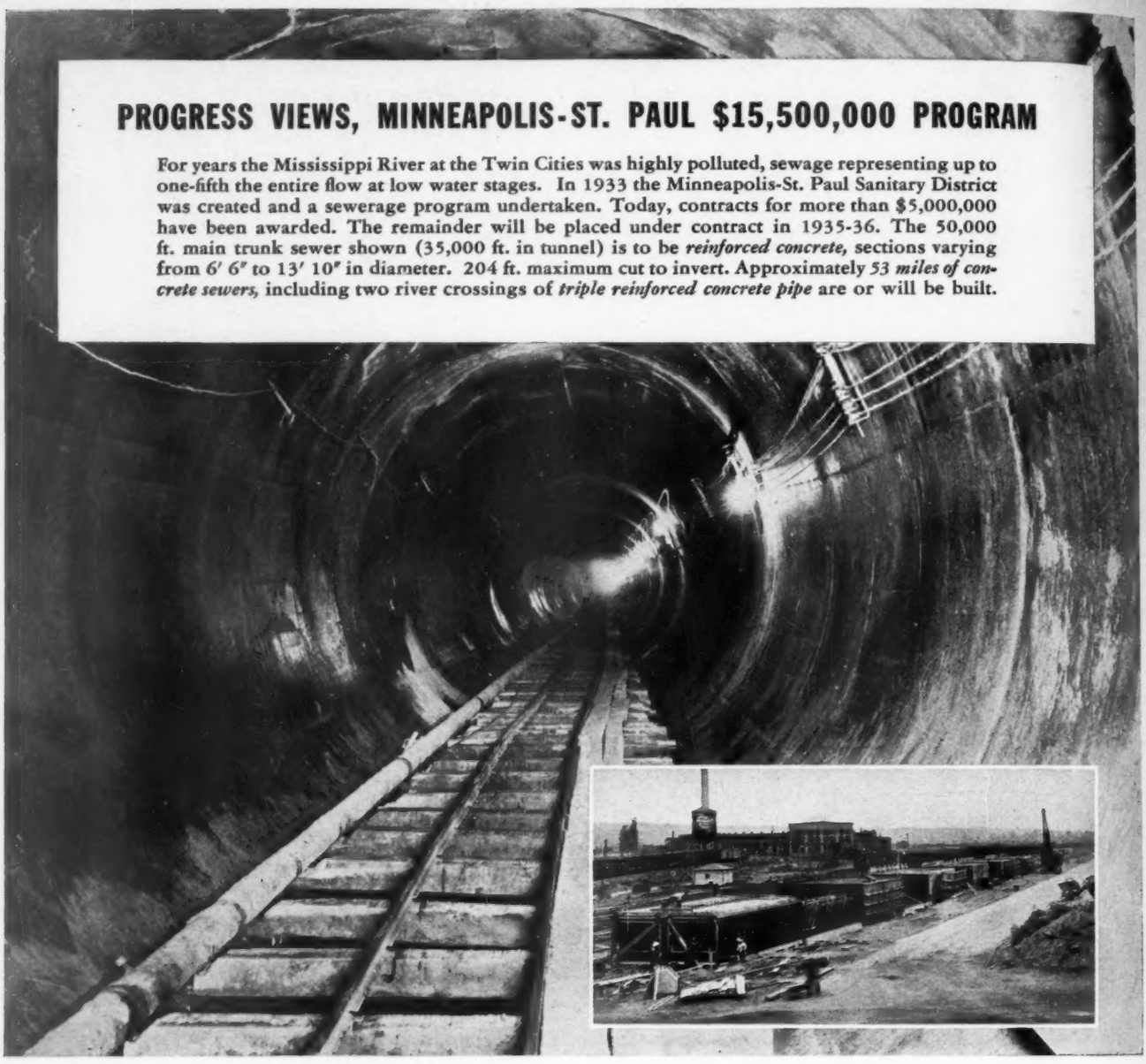


PROGRESS VIEWS, MINNEAPOLIS-ST. PAUL $15,500,000 PROGRAM

For years the Mississippi River at the Twin Cities was highly polluted, sewage representing up to one-fifth the entire flow at low water stages. In 1933 the Minneapolis-St. Paul Sanitary District was created and a sewerage program undertaken. Today, contracts for more than $5,000,000 have been awarded. The remainder will be placed under contract in 1935-36. The 50,000 ft. main trunk sewer shown (35,000 ft. in tunnel) is to be *reinforced concrete,* sections varying from 6′ 6″ to 13′ 10″ in diameter. 204 ft. maximum cut to invert. Approximately *53 miles of concrete sewers,* including two river crossings of *triple reinforced concrete pipe* are or will be built.

WHERE MILLIONS ARE AT STAKE SEWERS ARE BUILT OF CONCRETE

ON big sewerage projects such as those of the Sanitary District of Chicago, Louisville, Detroit, Baltimore, New Orleans, and other large cities—why is concrete chosen?

Where sewage pours from miles of collecting sewers into intercepters and outfalls bigger than railroad tunnels—why the universal reliance on concrete?

The answer is—concrete combines the necessary strength and durability at the most favorable cost. On its record this statement cannot be disputed.

Obviously concrete was chosen on these projects only after investigation proved its suitability. Whether *your* sewer is to be 12 feet in diameter—or only 12 inches—you play safe when you specify concrete.

Satisfactory sewer performance demands not only good materials but also proper design, construction and operation. Sewerage is a highly specialized field, and every project should be in the hands of an experienced sanitary engineer. Considering the investment his service is low cost insurance.

Facts on the use of concrete in sewers are available in booklets, *"Monolithic Concrete Sewers,"* and *"Concrete Pipe Sewers,"* free on request.

PORTLAND CEMENT ASSOCIATION

Room 99, 33 W. Grand Ave., Chicago, Ill.

News

OF A REVOLUTIONARY IMPROVEMENT IN SULPHUR COMPOUNDS FOR PIPE JOINTING!

Reducing Initial Leakage

IN BELL AND SPIGOT PIPE JOINTS

. . . BY AS MUCH AS 96%

THAT initial leakage, which you have accepted as unavoidable, can now be reduced *immediately*—and by as much as 96%.

Backfilling need no longer be delayed. Trenches need no longer be left open indefinitely—unsightly and a danger to traffic.

Even those who have had such satisfactory experience with MINERALEAD will find a revelation in the new jointing compound—TEGUL-MINERALEAD.

Repeated tests have averaged 1/25th as much initial leakage as occurred when ordinary compounds were used on the same lines.

ABSOLUTE UNIFORMITY ● Great reduction in initial leakage is but *one* of TEGUL-MINERALEAD's remarkable advantages. With it there is no physical change during shipment, storage and handling—no separation of ingredients as in compounds in powder form.

TEGUL-MINERALEAD comes in ingots. Its composition is maintained perfectly from our plant to the moment it goes into the melting pot on your job. Incidentally—these ingots are easy to store, ship and handle—impervious to dampness when left out-doors—and more can be added to the melting pot without slowing up the job.

MUCH MORE ELASTIC AND SHOCK RESISTANT

● *Tegul-Mineralead is Three Times More Elastic* than any other sulphur compound—*Has Twice the Resistance to Mechanical Shock*—as from heavy traffic—and is *Twenty Times More Resistant to Thermal Shock*—sudden temperature changes.

Joints made with TEGUL-MINERALEAD are permanent under conditions where ordinary sulphur compounds cannot be used, as, for example: in lines carrying hot water.

THE COST? Initially but little more — Eventually decidedly lower! The amount of TEGUL-MINERALEAD required for a given job is no greater. The initial cost is a trifle higher. The eventual economy is beyond question.

You want to know more about this remarkable new compound, with advantages we have but touched upon in this advertisement. Perhaps right now you are planning, or about to start a job on which TEGUL-MINERALEAD will save you plenty of time, and trouble—and money as well. There'll never be a better time to put the coupon to work than right now.

The Atlas Mineral Products Co. of Pa.
Mertztown, Pa.

We would like more information about the new TEGUL-MINERALEAD Jointing Compound.

We have in mind a job on ..... feet of ..... inch diameter bell and spigot pipe.

Firm and/or Title.....

Mr. .....

Address .....

Remarks .....

Tegul-

MINERALEAD

THE ATLAS MINERAL PRODUCTS COMPANY
of Pennsylvania
MERTZTOWN, PA.

Manufacturers of
G-K SEWER COMPOUND MINERALEAD
AMPCO SEWER JOINT COMPOUND
ACCESSORIES VITROBOND TILESET

BUILT

to give more years of better service

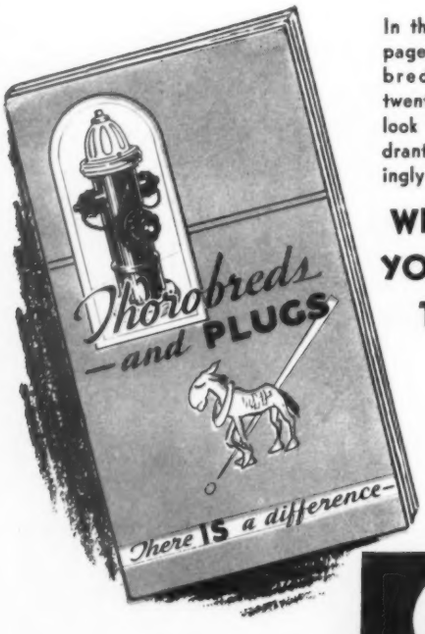
GOOD news travels fast. Wherever Columbian Fire Hydrants have been installed the word has gone out that they are built to work right under all conditions—always.

Examine the Columbian and you will see why it has won the admiration of those who use, maintain, or purchase hydrants. Start at the operating end. The dry top construction with the perpetual self-oiling feature is a long step ahead. There is no possibility of freezing in the bonnet or freezing of the operating nut—no jambing of the threads due to faulty oiling—no corrosion of the stem threads because they are constantly protected by an oil film—no drying out of the packing because it is constantly moistened by oil.

Now go down to the business end. The simple, finely built drain valves assure complete drainage and eliminate all possibility of freezing in the barrel. The main valve of special chrome-tanned leather has twice the life of ordinary valves. A bronze bushing in the shoe provides bronze to bronze threads for the seat ring and makes removal easy. A special copper gasket prevents leaking at the seat ring threads. Since the Columbian is a compression type hydrant, water is shut off *only when repairing main valve!*

And last, but not least, note the Columbian Safety Flange and Coupling at the ground line. It not only cuts the cost of breakage by trucks and automobiles from about $50.00 to $5.00. It also provides an inexpensive way of lengthening hydrants when grades are changed—an ideal way of swiveling nozzles or changing from hose to steamer nozzles at lowest cost and without digging. This will be your final reason for installing Columbians.

Columbian has found the answer to your fire hydrant troubles.



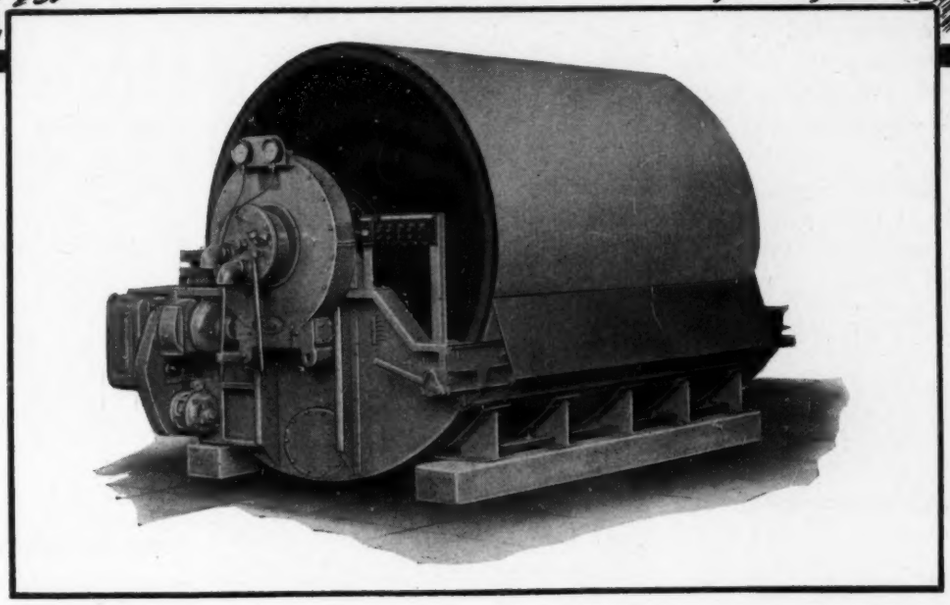
In this pocket-size 64-page booklet, "Thorobreds—and Plugs," twenty-seven points to look for in fire hydrants are interestingly presented.

WRITE FOR YOUR COPY TODAY

COLUMBIAN IRON WORKS
Chattanooga, Tennessee
Division of MUELLER CO.
Decatur, Illinois

COLUMBIAN
FIRE HYDRANTS

Selected
FOR NEW YORK'S *Coney Island* SEWAGE TREATMENT WORKS



Oliver Mechanical Sludge Dewaterer

You can make all the "Whoopee" you like at Luna Park, but Old Father Knickerbocker has his eye on you. He looks out for his sons and daughters and their visitors.

He is too old to be fooled, too wise to be led astray—his discriminating mind causes him to protect the lives and pleasures of his great family with only the best.

He buys the finest of fire fighting apparatus, his police force has the most modern equipment—no untried gadgets for him.

That's why he selected an Oliver Sludge Dewaterer for his new Coney Island Sewage Treatment Works.

OLIVER UNITED FILTERS INC.

NEW YORK, 33 West 42nd Street CHICAGO, 221 N. La Salle Street

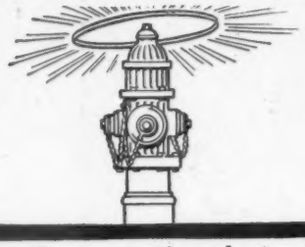
SAN FRANCISCO, 351 California St.

Yes—we would like you to mention WATER WORKS AND SEWERAGE.

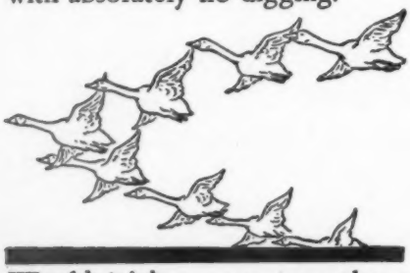
TO WATERWORKS MEN WHO ARE THINKING NOW ABOUT WINTER

Most cities have had enough water-supply grief in the past two winters to last for the next twenty. Of course it has been unusually cold, but the fact is that a series of mild winters has let too many engineers be persuaded that inadequate equipment, shallow trench-depths, and temporary repairs would do for another year or two.

Available federal funds make today the ideal time to recondition your water works system.



Let's ask one question that's pretty much to the point: Suppose you could find a hydrant that won't freeze up at any temperature, that can't be heaved loose by frost of any depth, that won't leak no matter where a skidding car may smash it, and one that can be repaired in the dead of winter with absolutely no digging.



Wouldn't it be an economy to have hydrants like that in the ground before winter starts? You can do it easily. The name is Mathews Hydrants, and here's proof of

every claim. . . . A properly set Mathews Hydrant will drain completely in less than two minutes. It doesn't have time to freeze even in sub-zero weather. Water-pressure is sealed away from the operating threads. No ice can form on them. Rain and spray are shed from its roof-like shield-operating nut. They can't leak in to freeze or rust. In other words —Mathews Hydrants don't freeze up. . . . Mathews Hydrants can't be heaved by frozen ground, because they are surrounded by a loose sleeve-like protection case which takes the thrust and is free to slide up or down without damage. It is this same protection case which lets the standpipe be unscrewed and lifted out without digging. . . . These hydrants don't leak when broken. No matter where they are smashed off, even 4 feet underground, the compression-type main-valve holds tight, eliminating icy floods and undermined streets. . . . Above all, and whatever happens, Mathews Hydrants can be removed, repaired, replaced, or overhauled above ground and without digging. Simply unscrew the barrel (standpipe) including all working parts, lift it out, and replace it.

If you have another winter like the last two, an investment in Mathews Hydrants will pay for itself in no time at all. Your community will be blessed with 60 years or more of instant, trouble-free fire protection, as that many years of actual service by Mathews Hydrants has repeatedly proved.

Today isn't a bit too soon to start arguing with your treasurer for a shipment of Mathews Hydrants. If you want prices, drop us a line.

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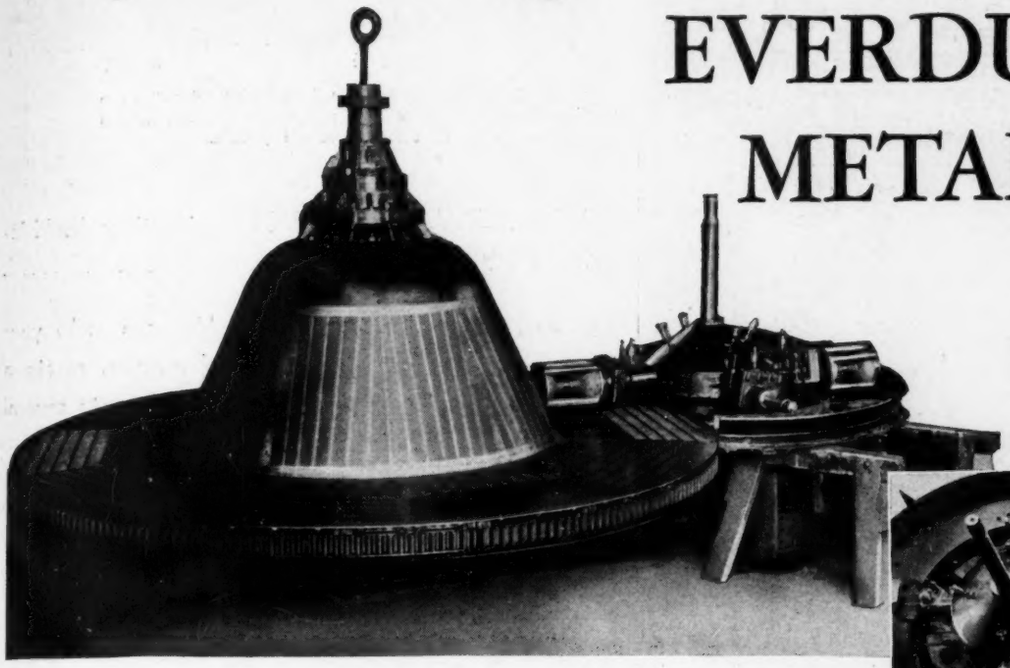
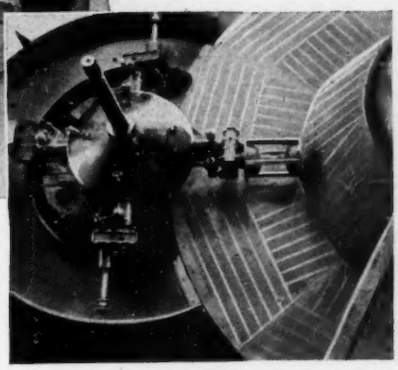
and "SAND-SPUN" PIPE, a superior grade, centrifugally cast in sand moulds.

SOLD BY ESTABLISHED 1803 **R. D. WOOD CO.** 400 CHESTNUT ST. PHILADELPHIA

12-foot Sewage Disc Screen of EVERDUR METAL





Shop assembly views of 12-foot Everdur sewage disc screen with revolving brush mechanism (brush staves not shown). Designed and furnished by Krajewski-Pesant Mfg. Corp., New York City, for the Stafford Springs, Conn., Sewage Treatment Works.

THIS 12-foot sewage disc screen, installed in the sewage treatment works at Stafford Springs, Conn., was fabricated of 3/16″ Everdur Metal plates. The *milled* tapered slots, 43,000 in all, measure 1/32″ x 2 1/2″. All screen segments were fastened to the framework with Everdur flat head screws, lockwashers and nuts.

The disc screen is installed on an incline and rotates, subjecting the Everdur screen plates to alternating submersion in highly corrosive sewage water. The revolving brush mechanism cleans the sewage screenings above the high water level.

The excellent corrosion resistance of Everdur, and its general ease of fabrication, have led to its extensive acceptance in the water works and sewage treatment fields. This moderately priced Anaconda alloy, with the strength and weldability of medium carbon steel, makes possible important savings in weight, plus unusual fabricating economies. Additional information on Everdur will be gladly supplied on request.

35272

EVERDUR METAL

"Everdur" is a registered trade-mark identifying products of The American Brass Company made from alloys of copper, silicon and other elements.

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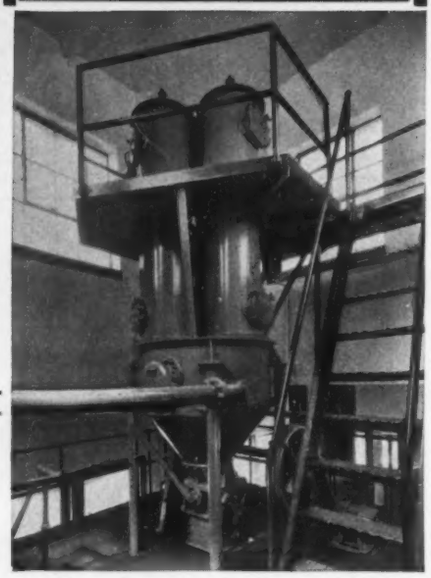

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Are Installed in the Following Plants:

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Municipal Water Plant.....Columbus, Ohio
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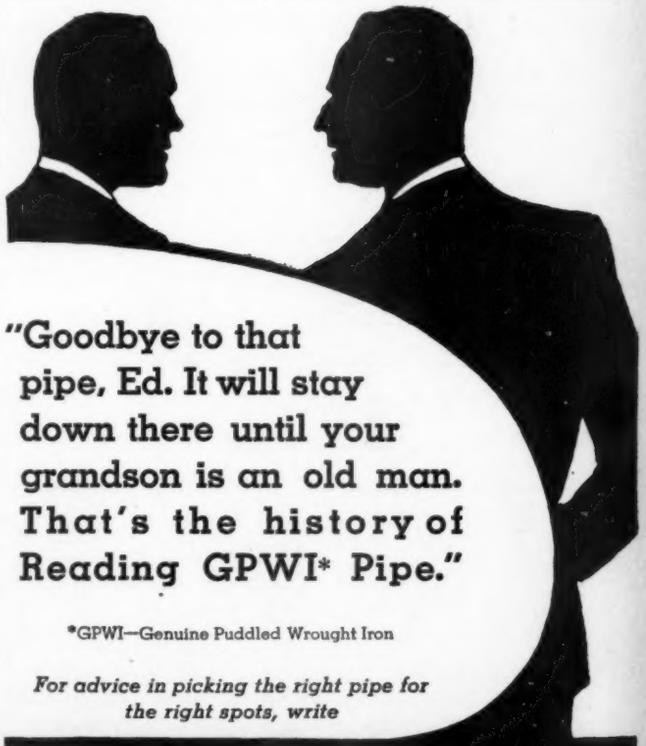

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*GPWI—Genuine Puddled Wrought Iron

For advice in picking the right pipe for the right spots, write

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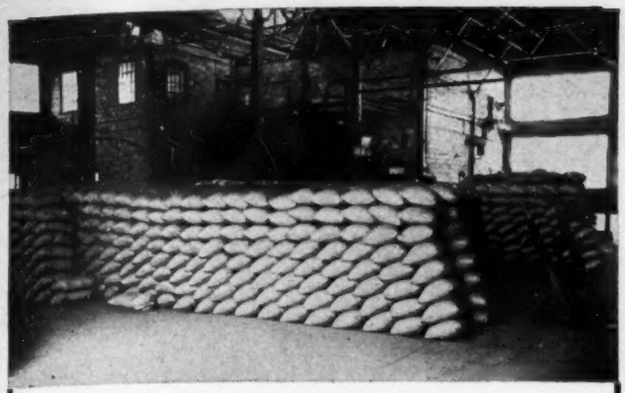

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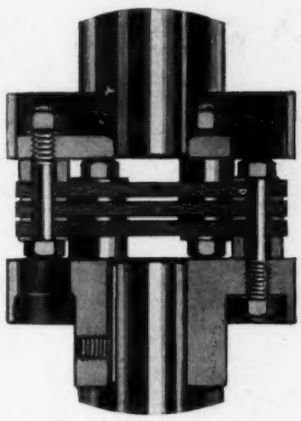

Above is a close-up cross-section of one of the Double Universal Flexible Couplings in the shaft of "Chicago" Vertical Open-Shaft Non-Clog Pumps. They compensate for any misalignment between motor and pump.

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Features

1—"Double Universal Flexible Coupling" in shaft compensate for any misalignment that may occur during or develop after installation.

2—Pump casing and bearing housing are machined with tongue-and-groove surfaces to insure perfect and constant alignment of shaft and impeller.

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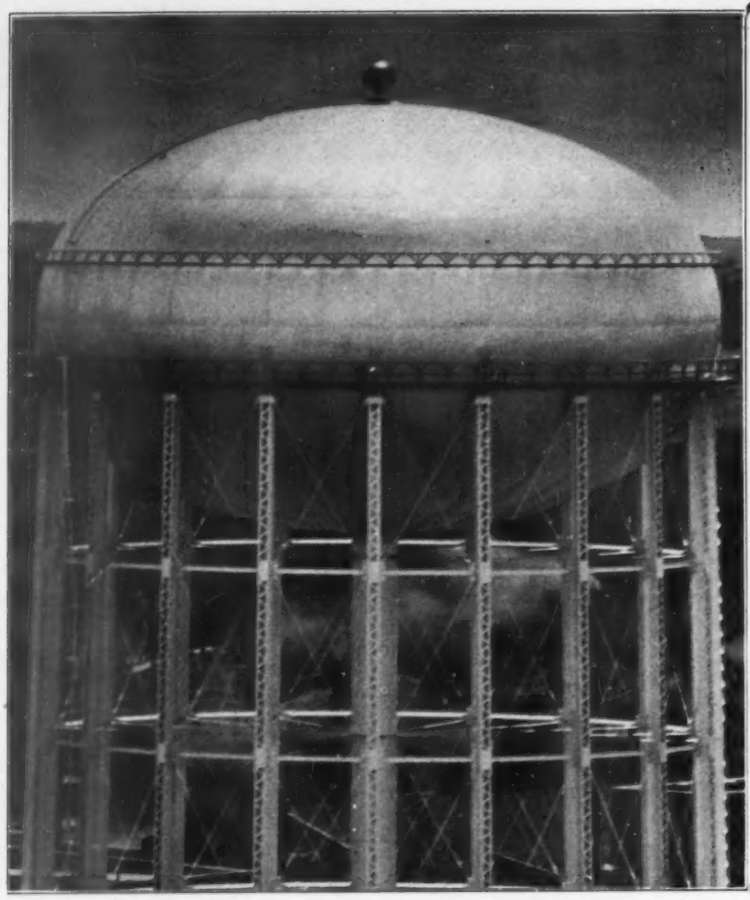
When writing to advertisers please mention WATER WORKS AND SEWERAGE—Thank you.



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Provides Abundant Ventilation and Light, Greater Safety to Operators, and Adds to the Appearance of the Plant.

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BEFORE

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Bell and Spigot Pipe and Fittings. From 4" to 54"
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RALPH C. WYATT SAYS:

"We have been using Mathieson Chemicals for Twenty Years"

Ralph C. Wyatt, Superintendent of the City Water Works at Danville, Ky.

FEW people are charged with a greater responsibility than that of the water works man—the responsibility of guarding the health of an entire community against the ever-present hazard of water-borne disease. Knowing the importance of their job, it is no wonder that water works men appreciate dependable chemicals and dependable service.

That is why, of course, the City Water Works at Danville, Kentucky, has been so long a user of Mathieson Chemicals. Mr. Wyatt, the superintendent, says: "We have been using your products in our water works for about 20 years now and in that time have found both the products and your service to be entirely satisfactory."

"We use both chlorine and ammonia in the filtering plant and for the past two years have also been using HTH. This latter product is used for sterilizing all new pipe lines and construction and we keep a supply on hand as a protection against any breakdown of the chlorinators."

"In addition we use quite a bit of HTH in helping out people in the vicinity who have their own water supplies. We continually are called on to advise such persons about sterilizing their water or clearing up some contamination and we have found HTH particularly effective in this work."

A 72-page handbook on water purification by W. L. Savell is available free of charge to city officials and engineers. This book, "Hypo-Chlorination of Water" (Second Edition), contains nearly 50 illustrations and shows up-to-date methods and equipment. It tells you what to do under both ordinary and emergency conditions—and how to do it. Send for your copy today.

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. . . are two words that have helped to build the reputation of EBG Liquid Chlorine. EBG users say it often. Old-timers tell newcomers. Newcomers become old-timers . . . and keep on recommending—with good reason . . . for EBG Liquid Chlorine is pure and uniform . . . and EBG service is prompt, courteous . . . and complete. Small wonder so many repeat, "I recommend . . . EBG!"

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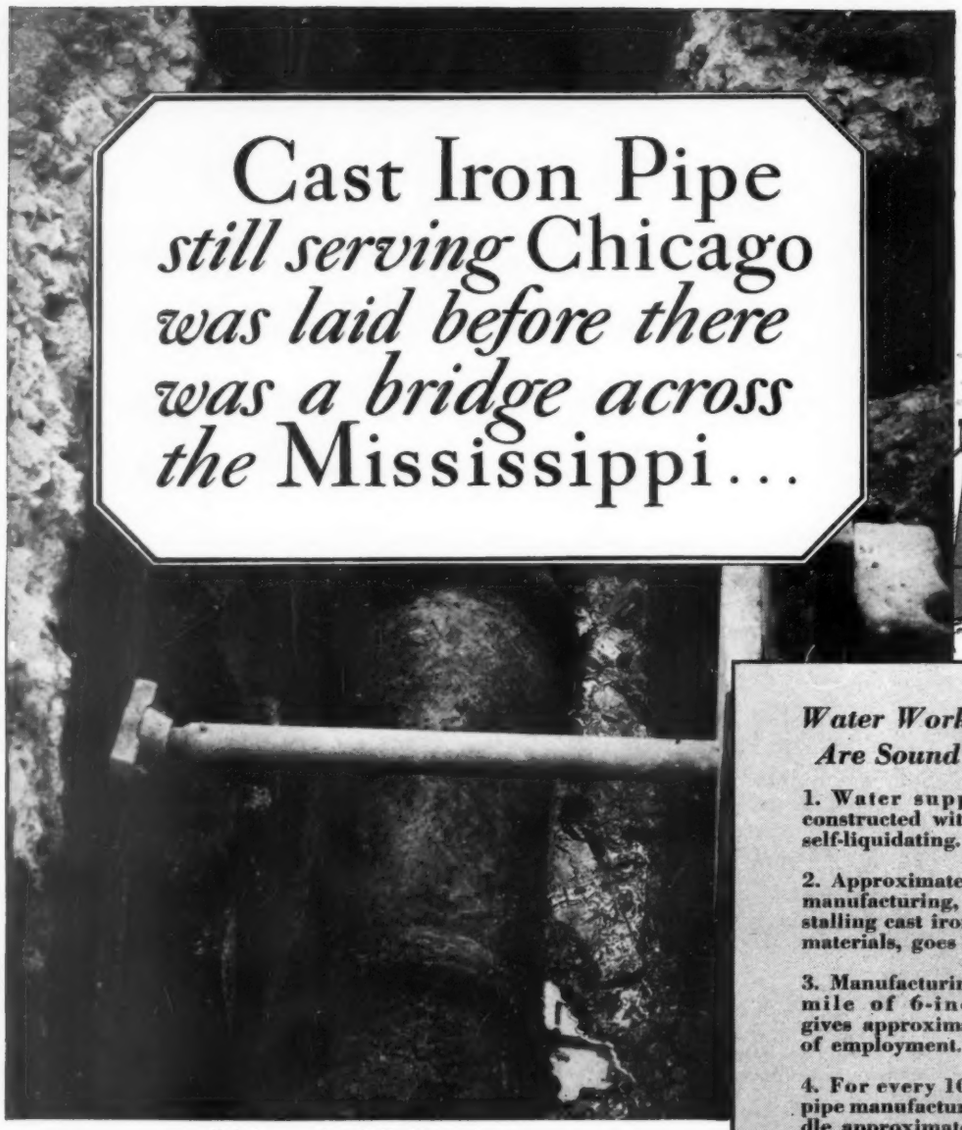


Cast Iron Pipe *still serving* Chicago *was laid before there was a bridge across the* Mississippi...

The first bridge across the Mississippi River was completed in January 1855 at Minneapolis.

Water Works Improvements Are Sound Relief Projects

1. Water supply improvements constructed with cast iron pipe are self-liquidating.

2. Approximately 75% of the cost of manufacturing, distributing and installing cast iron pipe, including raw materials, goes directly to workmen.

3. Manufacturing and installing one mile of 6-inch cast iron pipe gives approximately 1000 man-days of employment.

4. For every 100 tons of cast iron pipe manufactured, the railroads handle approximately 1000 tons of raw materials.

NO wonder Chicago's more than 3600 miles of water mains are cast iron pipe! Almost all of her original cast iron water line laid in 1851 is still in service. Sections not now in use were abandoned owing to changes incident to a growing metropolis. The pipe shown was recently uncovered and found in good condition after more than 80 years of continuous service.

In evaluating bids, engineers rate the useful life of cast iron pipe at 100 years, far beyond that of any other pipe practicable for underground mains. The long life of cast iron pipe is attested to by mains still in use here and abroad after one, two and nearly three centuries of service. Cast iron has long been the standard material for water and gas mains.

Cast iron pipe *costs less per service year* and *least to maintain* because of its effective resistance to rust. It is the one ferrous metal pipe for water and gas mains, and for sewer construction, that will not disintegrate from rust.

Your community has an exceptional opportunity to modernize, enlarge or extend its present water distribution system, or build new supply lines, at costs and financial terms that may never be so favorable again.

For further information, address The Cast Iron Pipe Research Association, Thos. F. Wolfe, Research Engineer, 1015 Peoples Gas Building, Chicago, Ill.

CAST IRON PIPE

METHODS OF EVALUATING BIDS NOW IN USE BY ENGINEERS RATE THE USEFUL LIFE OF CAST IRON PIPE AT 100 YEARS

TRADEMARK REG.

WATER WORKS AND SEWERAGE
A GILLETTE PUBLICATION
VOL. LXXXII SEPTEMBER, 1935 NO. 9

The Water Works of Lancaster, Pa. Front to Rear: New Filters, Dorr Clarifier, Clear Water Storage and Aerators (Old Filter Plant); Pumping Station Beyond the Dam.

THE WATER WORKS OF LANCASTER, PA. ON ITS ONE HUNDREDTH BIRTHDAY

By JAMES J. MALONE

Superintendent, Bureau of Water, Lancaster, Pa.

The Author

IN 1835 Lancaster printed script to finance its first water works which, by means of water wheels and steam pumps, forced the untreated water of Conestoga Creek to a 2,500,000 gallon reservoir in the east end of town, from which it was distributed by gravity to the inhabitants. In those days everyone had to tie cloth bags over their faucets to catch the small fish and other bits of foreign matter which came along with the water and, if reasonably clear water was desired for washing clothes, it was necessary to allow the water to stand in large tubs for a day or more.

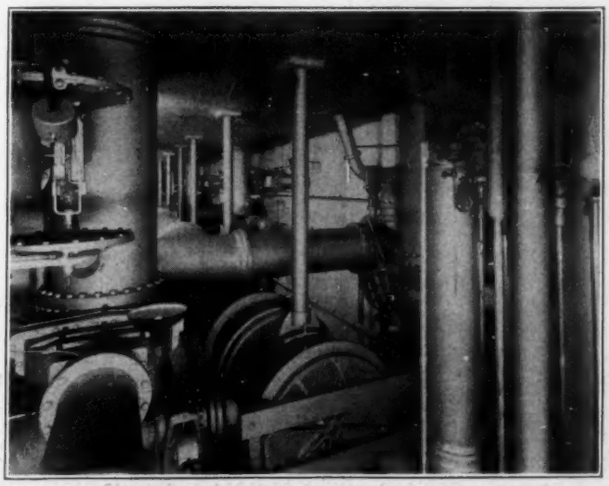
When it became apparent that the original water works were becoming inadequate to care for the increasing needs of the growing town, a new steam pumping station was built, in 1888, several miles above the site of the City Mill, as the first works were called. At the same time the capacity of the reservoir was increased to six million gallons by building an adjoining storage basin. In 1902 a half million gallon standpipe and booster station were constructed, on land adjacent to the reservoirs, to maintain a higher pressure in the distribution system.

Both the sanitary and esthetic quality of the water, however, grew so poor that in 1904 a private company built a slow sand filtration plant across the creek from the pumping station and sold filtered water to the city. In 1916 the city electrified its pumping station, and in 1925 purchased the filtration plant from the water company. In the same year a million gallon standpipe was constructed in the west end of the city. The following year a sedimentation basin with Dorr cleaning mechanism was built at the filter plant. This was the first application of Dorr cleaning apparatus to water purification work.

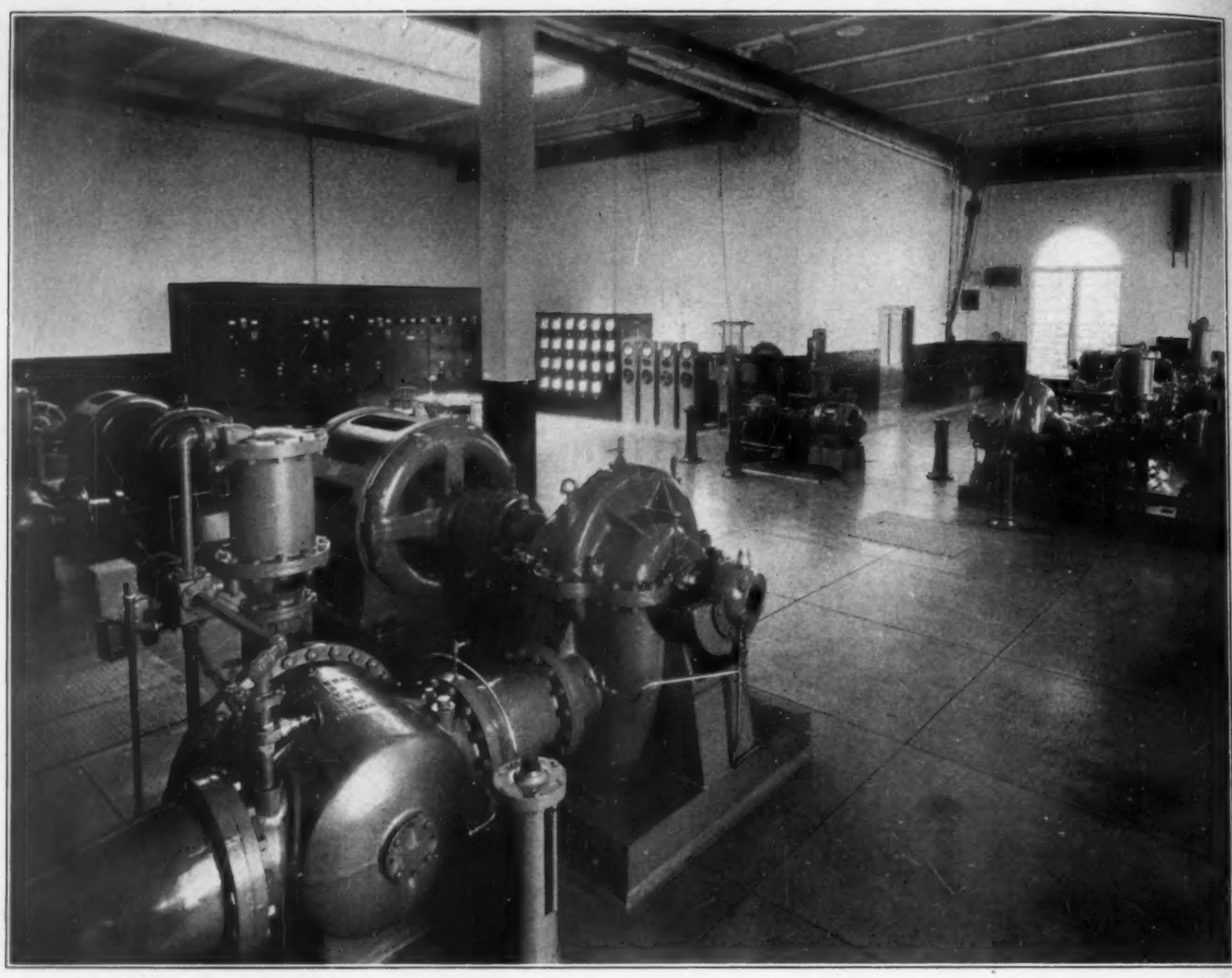
Although the old filtration plant produced a water which was vastly superior to that which had been supplied before its construction the pollution of the source had gradually increased, as had also the standards governing the tolerable limits of impurities. After an intensive educational program suggested by the State Department of Health, a $3,250,000 bond issue was approved by the voters in 1929 to finance the construction of a modern filtration plant and pumping station, and an adequate sewage disposal system with treatment works.

Pumping Station

Economic considerations made it desirable to reconstruct the existing pumping station, rather than to build a new one. Accordingly, the old station was modernized and almost completely rebuilt. A Link-Belt self-cleaning trash screen was installed at the original low duty intake. The pumping station was rearranged to con-



Pipe Gallery—Lancaster, Pa. Master Control Equipment Appears in Left Foreground.



Pumping Station—Lancaster, Pa. On Left: High Duty Pumping Units and Cone Valves. On Right: Low-Duty Units. Center Rear (behind Pump): Original Interesting Venturi Meter Indicator-Recorder Installed in 1905 and Still in Service.

tain a series of low duty raw-water pumps of five, ten, and fifteen million gallons per day, and a similar high duty series for the treated water. The installation consists of Worthington pumps, powered by Westinghouse motors, and protected with Chapman automatic cone-valves. To supplement the original thirty-inch line to and from the filter plant, a new thirty-six-inch line was installed. Since the average daily pumpage is approximately seven million gallons, the ten million pump is operated daily for a period sufficient to make up for the lack of capacity of the five million unit. The fifteen million pump is operated for one hour a week to insure its constant readiness in case of emergency. The original raw water Venturi tube and integrating meter which was installed by Builders Iron Foundry in 1905, is still in service. It was among the first meters of this type placed in service in this country.

Storage and Distribution

Conestoga Creek has always been an unfailing source of supply, even during periods of severe drought. However, to care for a possible temporary depletion of the supply, five foot flash boards were made which can be placed on the dam in half a day. It was calculated that this increase in the height of the dam will impound some 90,000,000 gallons of raw water. The flash boards are not kept on the dam permanently because, during the summer flood period, they back up so much water that property damage might become excessive.

The Holtwood power plant is the main source of electricity for the water works, through a double transmission line. A double emergency line runs to the works from Safe Harbor, and both the Holtwood and Safe Harbor lines are tied in with a line from Conowingo. In addition to these, lines are run from both the Lancaster and the Ephrata transformer stations. Through this power hook-up it is almost impossible to imagine the circumstances under which the pumping station would be without a source of electrical energy.

The first unit in the new water works system was a five million gallon standpipe (1931) erected in the west end of the city and near the standpipe which had been built in 1925. This tank, 100 feet in diameter and 92 feet high, is the largest tank of its kind in the world. All standpipes and reservoirs are linked together on a loop made around the city by the distribution system. From the pumping station a thirty-inch line runs to the east end standpipe and thence, through the south side of town, to the west end standpipes. A thirty-six-inch line runs from the pumping station to the west end standpipes through the north side of the city. These two lines are tied together across the eastern end of the city. By means of this loop, no section of the town would be without water should there be a failure of a major element of the distribution system.

The two smallest standpipes are controlled by altitude gages, while the large one is controlled by a telemetering unit in the pumping station. At such times as the pressure builds up in the system, water is sent to the reservoirs through a by-pass from the thirty-inch main

to an emergency thirty-six-inch main which runs directly from the pumping station to the reservoirs. At all times two 1¼-inch lines spray water into the reservoirs from the high pressure main. On Monday mornings, during the peak demand, water is pumped from the reservoirs into the east end standpipe by a booster pump which insures a complete turnover of the stored water. All the standpipes float on the distribution system to maintain a constant and satisfactory pressure in all parts of the city. Depending upon the height of the water in the various storage tanks and the pressure at the pumping station the neutral pressure point, however, may fluctuate as much as a mile in the distribution system.

Mains and Meters

The system contains about ninety miles of cast iron pipe varying in size from four-inch to thirty-six-inch. The supply, which reaches about 75,000 persons through 16,004 services, is 100 per cent metered. The only water which is not metered is that used by the fire department and that wasted during the flushing of mains.

Filter Plant

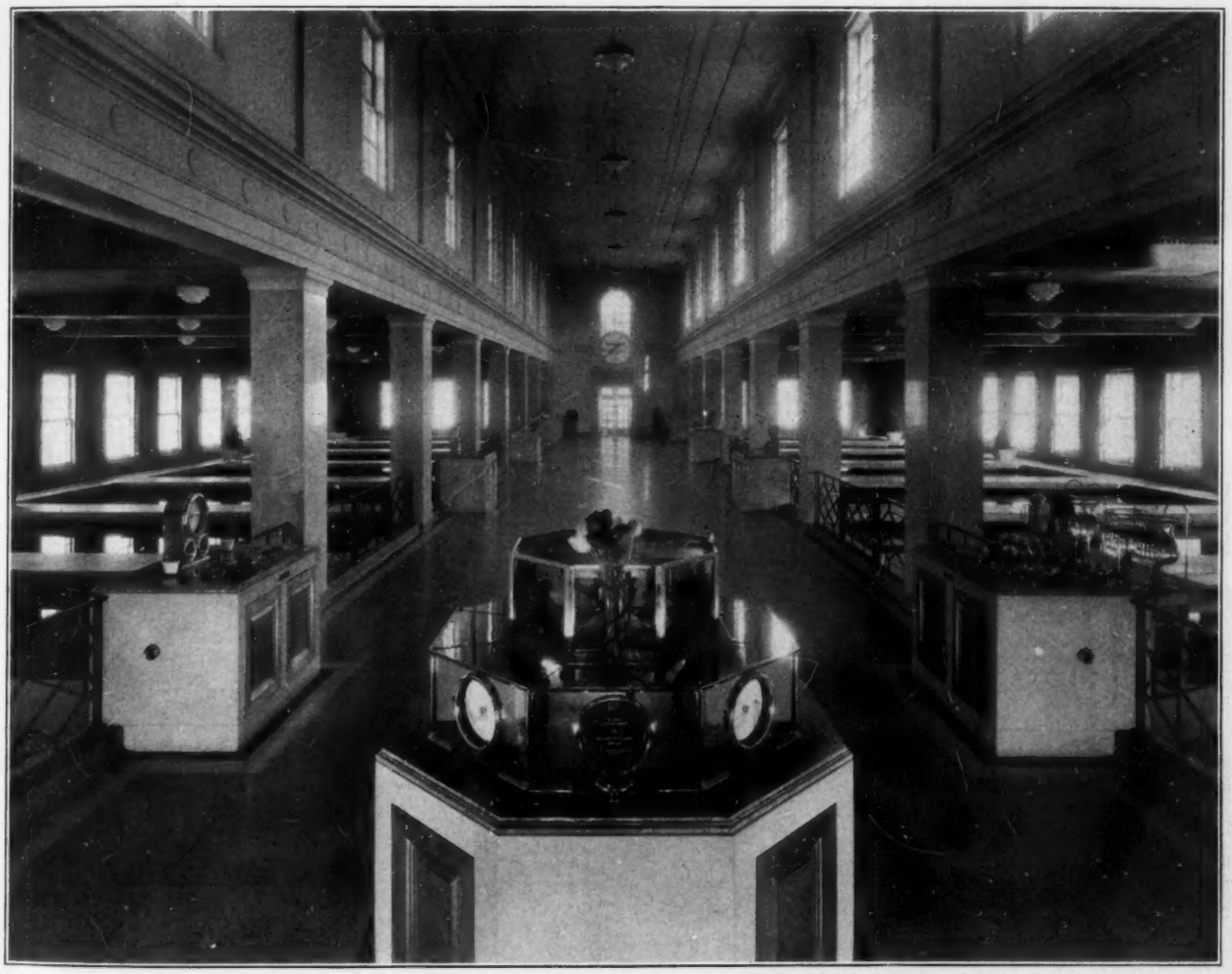
The new filter plant (see cover illustration), which was constructed near the site of the old plant, is built of native blue limestone with Indiana limestone trim. The main corridors have terrazzo floors with walls and operating tables in pink marble. Instrument panels and operating instruments are finished in chrome plate. It is fitted throughout with bronze doors and wood sashes and frames.

The new plant is of the rapid sand type designed for an ultimate capacity of sixteen million gallons per day, with 50 per cent overload. It was placed in operation in October, 1933, and is, at present, operating at about 42 per cent of capacity. All pipes and flumes are blanked off to permit extensions without rebuilding the present plant or interrupting its operation.

Both the thirty and the thirty-six-inch raw water mains enter the chemical feed building at the same point, and each main is used alternately during different periods of the year. At the point where the mains enter the building, raw water samples are obtained for analyses through a small Gould centrifugal pump with a sight glass.

Mixing Devices

The primary mixing basin, where the chemicals are applied, is a 5x5 foot concrete flume 75 feet long. It contains both vertical and horizontal baffles and is located directly above the secondary (flocculating) mixing basin. The secondary basin has the same cross-section as the primary, but is twice as long. The water enters it from the primary chamber and is distributed to six flocculation chambers which are 25 feet square and 16 feet deep. These chambers are equipped with stirring paddles directly connected, through Universal Gear Co.'s helical gear speed reducers, to one horsepower General Electric vertical motors. A system of Rodney Hunt



Filter Operating Floor—Lancaster, Pa. Builders Iron Foundry Master Control Table, in Foreground, Is as Ornamental as It Is Useful. Note Observation Glasses in Rear of First Operating Table on Right.

gate valves is so arranged that the chambers may be operated either in series or in parallel or in any series-parallel combination. At present they are all being operated in parallel. The total capacity of the six chambers is about a half million gallons and the present nominal flocculation period is about two hours.

Chemical Feed

Chemicals are applied through Municipal Service reciprocating dry feed machines with solution tanks. There are three machines for alum, one for lime, and one for activated carbon. There are also two small dry feed machines which were designed for use with ammonium sulphate, but these are not being operated because anhydrous ammonia in cylinders has been found much more satisfactory. One of these machines is being used for feeding a mixture of alum and copper sulphate for algae control. The dry feed machines are normally operated by telemeter control from the raw water Venturi so that the chemicals are always fed in exact proportion to the pumpage. They can, however, be operated by manual control. Chemicals are stored directly over the dry feed room to which they are elevated by a Stephens-Adamson bag hoist. From the storage room the chemicals are placed directly into the hoppers of the dry feed machines. The operators keep a record, on a special report form, of all the chemicals placed in or taken from storage, and thereby a perpetual inventory of chemicals used and on hand is available.

Activated carbon can be applied either to the raw or to the partially settled water entering the secondary settling basins or to both. For normal operation, application to the partially settled water has been found most satisfactory, and a constant dose of from three to six pounds of Aqua Nuchar per million gallons is being used at all times. This dosage is increased when tastes or odors appear or seem imminent, and it has been found an exceedingly valuable tool in the control of such difficulties.

Clarification

From the flocculation chambers the water is carried, in the lowest of three 4x6 feet rectangular concrete flumes (stacked vertically) to the Dorr Clarifier. This preliminary sedimentation basin has a capacity of a half million gallons and affords a detention period of approximately two hours at the present rate of operation. The sludge which settles to the floor of the basin is moved to the center by the scraper mechanism. From this point it can be drawn to the sewer, either by partly opening the discharge valve or by operating a diaphragm sludge pump. This basin removes from 75 to 90 per cent of the settleable matter in the water and has been found invaluable for keeping down sludge accumulation in the secondary basins, which are less easily cleaned. Several times during the year the primary Dorr Clarifier is shut down and cleaned thoroughly with fire hoses. In the winter a considerable thickness of ice forms in the tank, which is exposed to the weather, and this is cut away from the walls each day to prevent damage. The cleaning mechanism cannot be operated in severe winter weather because of ice formation, but during such periods the sludge content of the water is normally low and much of that which is present can be removed by opening the discharge valve, because the floor of the basin slopes toward this opening.

Chemical Feed Room—Lancaster, Pa. In Left Foreground: One of the Universal Gear Drive Units on the Vertical Flocculators. Sampling Station and Work Bench with Omega Stirrer for Floc Tests Is Out of Range of the Camera.

The partially settled water now returns to the chemical feed room through the middle of the three flumes. Here it rises through foot valves into the third and topmost flume from which it flows into the sedimentation basins through a series of 420 three-inch perforations in the end walls of each of the two basins. These two basins are each 125x75x16 feet deep and hold one million gallons each. They are being operated in parallel with a nominal detention period of eight hours. The basins are covered, and are cleaned in the spring and in the fall. A twelve to thirty-inch accumulation of sludge is generally found when the basins are cleaned. Before the use of activated carbon was begun this sludge had a very offensive odor, but since feeding a small constant dose the sludge has only a slight musty odor when the basins are drained.

Filters

From the sedimentation basins the water flows to the filters, of which there are eight, ranged four on each side of the operating floor, the filtration rate of which is controlled by a master rate controller. The beds are each 712.5 square feet in area and are divided into two sections between which is the flume which serves both to carry the settled water on to the filters and to take the wash water to the sewer.

The beds contain ten inches of gravel, graded from two-inch to three-eighths inch. Above the gravel, and separated from it by a bronze screen (10 mesh, wire 0.032 in. dia.), is a thirty-inch sand bed. Beneath the bed is a false bottom, and the wash water is distributed through bronze umbrella type strainers set six inches on centers in this false bottom. There are 3400 strainers to a bed and bronze delivery tubes carry the filtered water through the false bottom to the sub-base from which it flows, through rate controllers, to a 5x5 foot concrete clear water flume. Wash water is supplied to the sub-base of the filters from two 100,000 gallon tanks, forty feet high. These are filled by centrifugal pumps which start automatically as soon as the water falls below the forty-foot level. The beds are washed at rates of 16,000 to 18,000 gallons per minute to effect a vertical rise of about 38 inches per minute, through which the sand is expanded approximately 50 per cent. During 1934 the wash water averaged 2.05 per cent of that filtered. At present two beds are being washed every day, and allowed to rest for about two hours before being returned to service, giving an average run per bed of about 92 hours. Each bed has its own operating table from which the hydraulically controlled valves are operated. On the first operating table is a series of sample faucets supplied by reciprocating water pumps with raw, coagulated, primary settled, secondary settled, and filtered unchlorinated water. Be-

hind the table is a series of glass display tanks in which the water, in its various stages of treatment, is constantly circulated in order that the visitor may see the clarification which takes place in each step.

The operators keep a record of filter operation on a special form which shows the time each filter is placed in or taken from service, the time it is washed, the duration of the wash, the amount of wash water, the rate of flow and loss of head before and after washing, the length of filter runs and the total daily filter-hours. On another form they record hourly readings of the filtered water Venturi meter, pumpage and filtration rates, master control setting, chlorine and ammonia meter readings, chlorine residuals, and the depth of water in the lower and upper clear water basins. This sheet also shows the amount of water filtered daily, wash water and chemicals used, filters and stirrers in service, and a record of the weather which is taken three times daily.

Pipe Galleries

In the pipe gallery, which lies immediately below the operating floor of the filter room, are all the valves which are used in the operation of the filters proper, the rate of flow and loss of head gages, and the master control apparatus. In the basement, adjoining the pipe gallery, are two sand washing tanks into which the sand may be delivered from the beds by an ejector and rubber hose. After proper treatment the sand can be returned to the beds by an ejector. This arrangement eliminates the need for sand decks and makes for ease and neatness when work on the filter beds or strainer system may be required.

Post Treatment

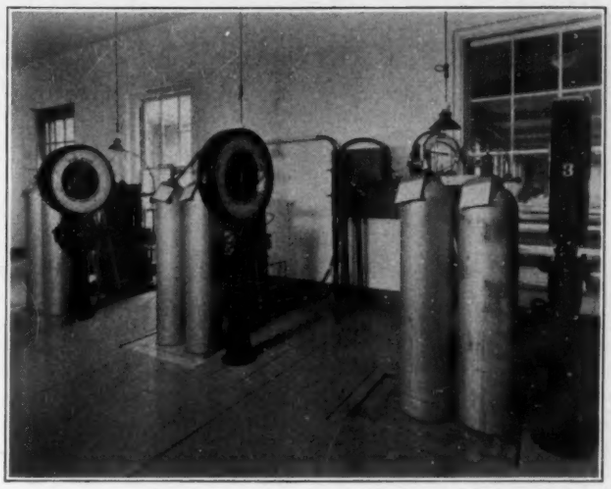
At the juncture of the clear water flumes from the two sets of filters, ammonia gas is applied at a rate of approximately one pound per million gallons through a Pardee ammoniator. Lancaster was one of the first cities to use ammonia in conjunction with chlorine and was the very first to use an ammoniator. About twenty feet further in the same pipe, chlorine is applied at a rate of about three pounds per million gallons through Wallace & Tiernan chlorinators. This is sufficient chlorine to maintain a residual of about two-tenths part per million at the plant.

There are one manual and two automatic vacuum type solution feed chlorinators which are so set up with a valve system that any of the three may be used for either pre- or post-chlorination. The water may be prechlorinated at the point where the raw water enters the building, in the primary mixing flume, or in the partially settled water on its return from the Dorr Clarifier.

The clear water, after ammoniation and chlorination, passes through a Venturi tube to the lower clear well. This basin was used by the old filter plant and was rebuilt by gunniting and covering. It has a capacity of about 1,440,000 gallons.

Aeration

A novel feature of the new plant was the conversion of the old slow sand plant into an aeration basin with a storage capacity of 1,750,000 gallons. Holes were cut in the walls separating the old filter beds and pre-scrubbers so that the water flows up through the old filters, turns, and comes down through the old preliminary scrubbers. The downtake to the high duty pumps is located in the last of the old scrubbers. The aerator is operated only during the warmer weather and is so built that the water from the lower clear well may be forced either through the aerator nozzles or through a thirty-inch main to the first of the old filters. A fifteen million gallon vertical pump with dual automatic control starts to pump the water to the aerator as soon as the level of the water in the lower clear well reaches a point approximately fifteen inches below the clear well overflow. The pump stops either when the lower clear well level has been reduced two feet, or when the level in the upper basin rises to a point eighteen inches below the tops of the old filter walls. The aeration of the finished water makes it more palatable and sparkling, mechanically frees it from tastes and odors not caught by the activated carbon, reduces the free carbon dioxide from 50 to 75 per cent (depending upon the amount present), and does not reduce the residual chlorine, probably because of its combination with the ammonia added.



Chlorinator-Ammoniator Room—Lancaster, Pa. On the Wall Is the Valve Stand for Delivery of Chlorine to Various Points.

Laboratory

The filter plant contains a large completely equipped chemical and bacteriological laboratory with a full time chemist in charge. The usual physical and chemical tests for turbidity, color, pH, alkalinity, free CO_2, residual chlorine, etc., are run daily (or as often as necessary), on the raw, settled, and filtered water. Seven samples are analyzed bacteriologically every day, as follows: one each of raw, settled, filtered unchlorinated, filtered chlorinated, one from the Municipal Building, and two from residences in different sections of the city. The residual chlorine is checked on all samples brought from the town. The operators have a small laboratory in the chemical feed room in which they take hourly readings of the turbidity on a Jackson Turbidimeter, determine residual chlorine, check the chemicals being fed by the machines by weighing the quantity discharged in a given time, and run jar tests on a six-gang Omega mixer as often as necessary. There is a rack in the operators' laboratory containing twenty-four quart jars, one of which is filled every hour from a flocculation chamber, and which affords a continuous record of the type of coagulation being obtained and guides the operator in the application of chemicals. During high water the operators also check the pH and the alkalinity and from these determinations decide whether or not lime is necessary.

Tables of average analyses for 1934 are shown below.

Irregular operation early in 1934 was responsible for the rather high figures for turbidity and color.

	Raw	Filtered	B coli Index	
Turbidity	124	0.3	Raw	920
Color	26	4.0	Settled	121
Alkalinity	112	100	Filtered	22
pH	7.7	7.1	Treated	0.08

It has been noted that coagulation reduces the bacteria about 90 per cent and filtration more than 99 per cent of those present in the raw water. Conestoga Creek is a flashy stream in which the turbidity may rise from less than a hundred to several thousand in a couple of hours. The maximum turbidity in 1934 was 6000. The bacterial content of the raw water varies from less than 100 to more than 20,000 per cubic centimeter.

MINERAL ANALYSES

	Raw	Filtered
Total Solids	198	176
Silica and Insoluble	28.9	11.8
Calcium	44.0	43.5
Magnesium	9.75	9.23
Hardness	151	147

(Iron and aluminum are present in negligible quantities.)

The mineral analyses, here reported, are the result of daily samples composited and analyzed weekly over a period of six months. The chemist makes a daily report of bacteriological analyses, a weekly report of plant operation, and a monthly analytical and operation summary on special forms.

Design and Engineering

The J. N. Chester Engineers of Pittsburgh, Pa., were the general contractor for the water works program. They sublet the construction contracts to D. S. Warfel, a local builder. The American Water Softener Co. installed the filters, using Builders Iron Foundry control apparatus. The Pitt Construction Co. installed all of the piping with the exception of that in the pipe gallery.

Costs and Rates

A chart is kept to show the operating costs of the water works, broken down into all the important elements responsible for them. [This is to be the subject of a brief article by Mr. Malone in a near future issue.—Editor.]

With the exception of power and chemical costs, the expenses of operating the water works are, for all practical purposes, fixed. During the last fiscal year the total operating expense made the water cost 9.07 cents per 1000 gals. delivered to the consumer service line. This circumstance opens the interesting speculation as to the benefit to be derived from encouraging an increased consumption of water for sprinkling, irrigation, and the like, if this added production could be made available through special meters at lower but also profitable rates. The present water rates in Lancaster are as follows: 25 cts. per thousand gallons for the first 75,000; 18 cts. per thousand for 75,000 to 1,000,000 gallons; and, 12 cts. per thousand for all above 1,000,000 gallons. These rates are based on total quarterly consumption. In districts outside the city limits the rates are, respectively, 60, 30 and 18 cts. per thousand gallons.

A water rate-case brought against the city by a taxpayer was recently settled in favor of the city after three years of litigation and a cost of some $30,000. After an appraisal of the water works system by outside experts, the court found that the return on the investment was 5¾ per cent and held that this was not an excessive profit. The court also held that profits from the water system could be diverted to the account of the Sewage Treatment Works through the General Fund.

The city has recently completed two activated sludge disposal plants, rated at six million gallons with 50 per cent overload possible, and three sewage pumping stations. The disposal system was also designed by J. N. Chester Engineers and was financed out of the $3,250,000 bond issue approved in 1929. Of this sum approximately $1,000,000 was used for the water works and the balance for laying additional sewers and building the disposal plants and pumping stations.

The management of the water works and distribution system is in the hands of Harry J. Stumpf, Commissioner of Public Safety; James J. Malone, Superintendent of the Water Bureau; Leon S. Duckworth, Filter Plant Manager, and Richard D. Hoak, Chemist and Bacteriologist.

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Paul Ivy, Sr., Meets Tragic Death

The following notice of the untimely and tragic death of Paul A. Ivy, Sr., Vice President and General Manager of National Cast Iron Pipe, came as a decided shock to the water works and sewerage profession at large, and to his host of personal friends.

*Paul A. Ivy, Sr.**

Paul Ivy had a vast experience in the manufacture and marketing of Cast Iron Pipe and fittings. He started in this business with the American Cast Iron Pipe Company which he served prior to his selection about 10 years ago, by James B. Clow & Sons, to manage its newly acquired subsidiary, National Cast Iron Pipe of Birmingham, Ala. In this position he made the success which one who knew him would expect him to make.

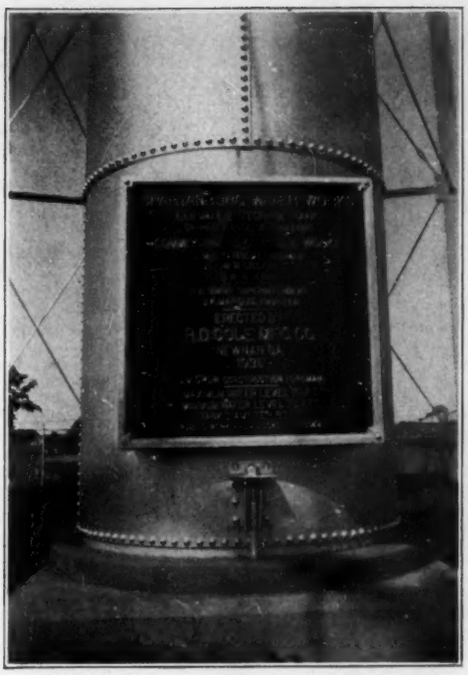
IT IS WITH PROFOUND SORROW THAT WE ANNOUNCE
THE DEATH ON AUGUST FOURTEENTH
NINETEEN HUNDRED THIRTY-FIVE OF
PAUL A. IVY, SR.
OUR VICE PRESIDENT
NATIONAL CAST IRON PIPE
A DIVISION OF
JAMES B. CLOW & SONS

Paul Ivy met his death on the fourteenth of August while traveling by plane across Texas on a business trip which he was making through the Southwest. The plane crashed and burned immediately.

(*The above snapshot of Mr. Ivy is probably the last one taken of him prior to his death. It was made as a candid-camera shot for WATER WORKS AND SEWERAGE during the recent convention of the Southeastern Section of A. W. W. A. in Birmingham. The occasion was a trip of inspection to the plant of the National Cast Iron Pipe Company.—Editor.)

SPARTANBURG, S. C. ERECTS A 1,500,000 GALLON ELEVATED STORAGE TANK

By R. B. SIMMS[1] and J. K. MARQUIS[2]



Name Plate at the Base of the New Tank.

R. B. Simms

SPARTANBURG has just completed an addition to its water works system by the erection of a 1,500,000 gallon capacity elevated storage tank. This improvement was made possible by a loan and grant from the Public Works Administration.

Plant: In the year 1924 the need for a new water plant became apparent, the city having outgrown the old plant which became deficient in capacity and quality of production. Selection of an adequate source of water necessitated going out from the city thirteen miles to locate a supply of such quality and quantity as to meet the need of the city for the years to come.

The south fork of the Pacolet River was decided upon as being the best adapted to the requirements. The new plant was completed and placed in operation in the month of May, 1926. It comprised six one million gallon filter units and three four million gallon centrifugal pumps and equipment for hydro-electric development of three million Kw output annually.

Pipe Line: A 24-inch main was laid from the plant to a concrete storage reservoir of 3,000,000 gallon capacity some three miles from the plant, this location having an elevation of 982 feet and being the highest point between the plant and the city. From the reservoir to the city, a distance of approxmately nine miles, a 27-inch C. I. main was laid. The water flows to the city by gravity, filling the old standpipe and the new tank (top line of elevation 922 feet), giving the city approximately a seven million gallon supply before the stored water reserve is drawn on. The present demand, summer load, is 4½ M.G.D. with a peak slightly in excess of pipe line capacity.

Before the erection of the new tank the only reserve storage and balancer on the system was a standpipe some 96 feet high and having a capacity of approximately 225,000 gallons. This standpipe is located between the pumping plant and the business district of the city. The top of this standpipe has an elevation of 922 feet, which is 60 feet lower than the water level in the new concrete storage reserve. This necessitated that the water from the new system be manually controlled at the old plant where the new and old systems join in order to insure a fairly constant pressure in the business section of the city.

The Underwriter's report of investigation and inspection of the water system in May, 1929, pointed out the need of additional storage near the center of distribution for the following reasons: first, to offset the immediate need of a dual pipe line from the concrete storage reservoir to the city; second, to hold a more constant pressure in the business high value district. An elevated storage tank was recommended to meet these requirements.

The New Tank Project

The Commission of Public Works filed an application for a grant and loan from the Public Works Administration for the purpose of erecting the tank in February, 1934. Final approval of the project was received September 18, 1934.

Bids were received for both a 1,000,000 gallon and a 1,500,000 gallon capacity tank. While a 1,000,000 gallon tank was sufficient to meet the Underwriter requirements, the 1,500,000 tank was the most economical in cost from a standpoint of capacity. The 1,500,000 tank was decided upon as being the best investment by the Commission from the following analysis.

Cost: The bid for the 1,500,000 gallon tank erected on our foundation was $57,884, that of the 1,000,000 gallon tank was $46,844. When you study the following cost of:

1½ million gallon tank erected	$57,884.00
Land site	7,500.00
Foundation	8,600.00
Pipe connections to distribution system	6,000.00
All steel 8 ft. fence	1,100.00
Altitude valve and long distance recorder	2,000.00
Engineering and inspection	3,000.00
Total approximate cost	$86,084.00

the $11,040 saving on the million gallon tank did not

[1]Superintendent of Water Works and Sewage Disposal.
[2]Engineer in Charge of Filtration and Pumping.

Spartanburg's New Tank—1,500,000 Gals. Capacity.

look good to us when we could get 50 per cent more water storage for an expenditure of $13,000 or $14,000 more—equivalent to about a 28 per cent additional cost.

Location: The location of the new tank is within a short distance of the main business district, in fact just one city block away, and is just beyond the center of distribution from the source of supply.

The location was not necessarily the highest elevation within the city but was selected because of a balance between the cost of land and cost of additional height of elevated tank. Securing the highest elevation of land is not the most economical because the additional cost of land over some other point not so high will frequently give a higher overall cost to the project.

Erection: The R. D. Cole Company of Newnan, Georgia, were the contractors awarded this job and this is the largest tank that has been erected by this firm. We think that the tank is neat in design and really adds to the "looks" of the city.

Erection was begun on the 10th of December, 1934, and completed July 10, 1935. The construction was really very remarkable in that there was not a single leak of any importance. The constructors are to be congratulated upon their good workmanship on this job.

Connections: The connections between the tank and the distribution consist of one 14-inch line to South Liberty Street, one 10-inch line to Kennedy Street and one 12-inch line to Broad Street and Main Street. All the lines connecting the tank with distribution systems are equipped with check valves so that the water is free to flow from the tank at all times. These check valves were installed so that a higher pressure than that furnished by the tank can be created if necessary at any time. This is to make available for the fire department a higher pressure in case of a serious conflagration.

Around each of the check valves is a by-pass for filling the tank. Around the 14-inch check is an 8-inch by-pass equipped with a Fisher Altitude Valve for controlling the water level in the tank. This altitude valve also is equipped with a solonoid switch which is controlled from the main station of the Fire Department. When a higher pressure than that furnished by the tank is necessary the fire department can close a switch, thereby closing the altitude valve and then a higher pressure will be built up in the distribution system.

At the old pumping station near the city limits we have installed an 8-inch reducing pressure valve (Fischer Type), which receives water at approximate 105 lbs. pressure from the main leading from the concrete reservoir and reduces it to a pressure of approximately 95 lbs. for distribution in the city. This valve has a capacity ,of approximately 4,000,000 gallons of water at this given pressure.

The elevation of the concrete tank foundation is 805.33 feet. The elevation of the high water level in tank is 922.35 feet—117 feet from foundation to high water mark. The entire 1,500,000 gals. capacity of tank is stored within 41 feet from the high water level. The riser pipe of the tank is 6 feet in diameter. The tank proper (see picture) is eliptical in shape, the diameter at the main axis being 87 feet. The tank is equipped with a Builders Iron Chronolo flow instrument which consists of a transmitter located at the tank site and a recording instrument located in the main office. This instrument keeps the water level in the tank right in front of the Superintendent's desk at all times.

The Commission of Public Works consists of three members, Dr. L. McD. Kennedy, Chairman; D. W. Hendrix and W. W. Griffin. Mr. R. B. Simms is the Superintendent of both the Water and the Metropolitan Sewerage Departments. J. K. Marquis, the co-author of this paper, was the engineer on this project, representing the Commission of Public Works, and Lockwood Greene Company, Engineers, were retained in an advisory capacity.

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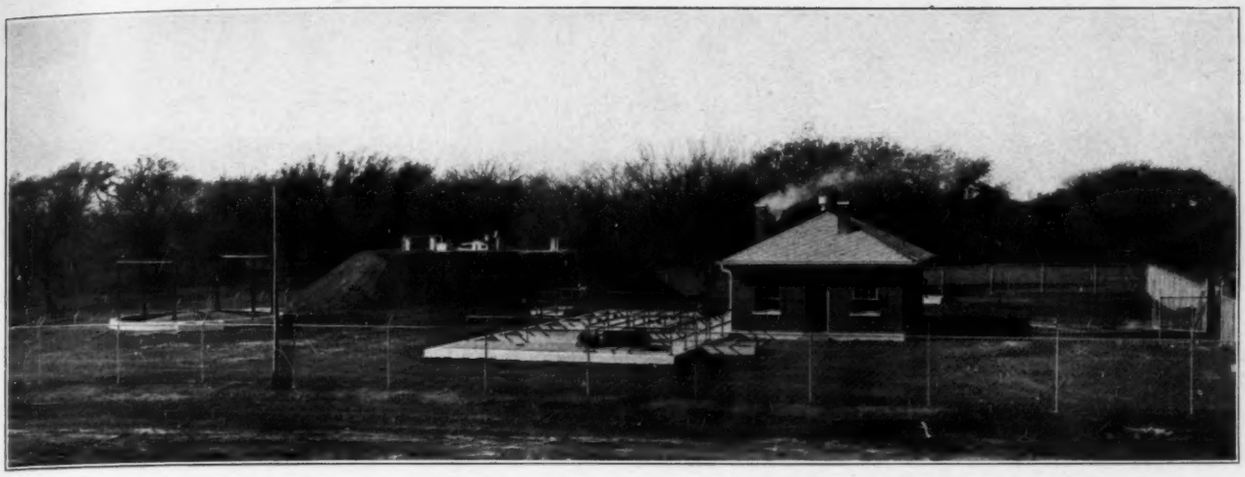
New York and New England Sewage Works Associations Will Hold Joint Meeting

A joint meeting of the New England and New York State Sewage Works Associations will be held at the Hotel Van Curler, Schenectady, N. Y., on October 4 and 5, 1935. For the technical sessions an interesting and varied series of papers has been arranged. Especially effective displays of sewage works equipment will be presented by a large number of manufacturers. On Saturday morning, the famous sunrise breakfast of the New York State Sewage Works Association and round table discussion, with the New England members as guests, will be followed by an inspection of the Schenectady and Canajoharie treatment plants. An interesting feature of the meeting is to be a tour of the General Electric "House of Magic," which will open the meeting on Friday morning. In addition to the technical sessions, entertainment features will provide a well-rounded program and it will be an outstanding meeting well worth attending.

Ladies are cordially invited to attend this meeting and a committee is planning an enjoyable series of social events for their entertainment during the technical sessions.



The New Chemical Sewage Treatment Plant of York, Neb.

THE SEWAGE TREATMENT WORKS OF YORK, NEB.

By F. M. VEATCH*
Kansas City, Mo.

SEWAGE disposal works, equipped for chemical treatment, and designed to treat an average daily sewage flow of 0.7 m.g.d. from a contributing population of 7,000, were put into operation at York, Nebraska, on October 1, 1934.

The purpose of these works was the elimination of nuisance in Beaver Creek, an intermittent and rather "flashy" stream into which the city sewage has been discharged for some twenty-five years. This stream is not used for domestic water supply, or for recreation and in view of the fact that the requirements of the problem so far as disposal is concerned, lie in the border zone between preliminary and complete treatment, the scheme of increasing the efficiency of purification by the use of coagulants was adopted.

After more than six months of operation, during which time the conditions along Beaver Creek have been entirely satisfactory, in spite of the fact that the natural flow of the stream has been practically nil, it seems safe to predict that this scheme of chemical precipitation will for all practicall purposes, solve the nuisance problem equally as well as one of the more expensive biological processes.

Description of Plant

The plant here pictured, and shown in detail in the layout in Figure 1, includes the following units:

1. Sewage pumps.
2. Mechanically cleaned bar screen with ¾ inch openings.
3. Primary settling tank, designed for a detention period of one hour and an overflow rate of 1,400 gallons per square foot of tank surface per day. Equipment of the "straight line" type of skimming and sludge removal is provided.
4. Mixing or coagulating tank, designed for a detention period of 20 minutes and equipped with two agitating paddles of the "flocculator" type.
5. Final settling tank, designed for a detention period of 2 hours and an overflow rate of 650 gallons per square foot of tank surface per day, and fitted with sludge removal equipment of the "straight line" type. The overflow weirs are formed of steel channels suspended in the liquid and provide a total weir length of 84 feet.
6. Sludge digestion tank, with a capacity of 14,000 cubic feet or 2 cubic feet per capita. This tank is of the "fixed cover" type and is equipped for heating and gas collection.
7. Sludge drying beds, with a total area of 11,500 square feet or 1.65 square feet per capita. No provision is made for underdraining the sludge beds, and no filtering material is used since they are located on land subject to frequent flooding.
8. A building to house the sewage pumps, screens, sludge pumps, gas boiler, chemical feeding machines, laboratory, etc.
9. A gas holder, with a capacity of 3,000 cu. ft.
10. Equipment for making ferric chloride, by passing a solution of chlorine over scrap iron, known as the (Scott-Darcy) process.

The arrangement of the tanks and the equipment in the machinery house is shown in Figure 2.

Operation

The screened sewage is passed through the preliminary settling tank, and thereafter receives the chemical dosage at the entrance to the mixing tank. The coagulated sewage is then clarified in the final settling tank and the effluent passes off over a measuring weir into the stream. The sludge from the final settling tank is drawn off by gravity into the raw sewage pump sump where it is mixed with the incoming sewage, and settlement with the raw sludge in the primary settling tank. The mixed sludge from the primary tank is pumped at hourly intervals into the sludge digester.

As shown in Figure 2 provision was made for applying chemicals in the raw sewage pump sump as well as to the primary settled sewage at the entrance to the mixing tank. Experience has shown, however, that there is no advantage in the former application. The returned chemical sludge seems to have some coagulating effect, and the mixing of this with the raw sewage has caused no trouble from odors. A pump was provided for handling secondary sludge direct to the digester but so far it has not been needed.

*With Black & Veatch, Consulting Engineers.

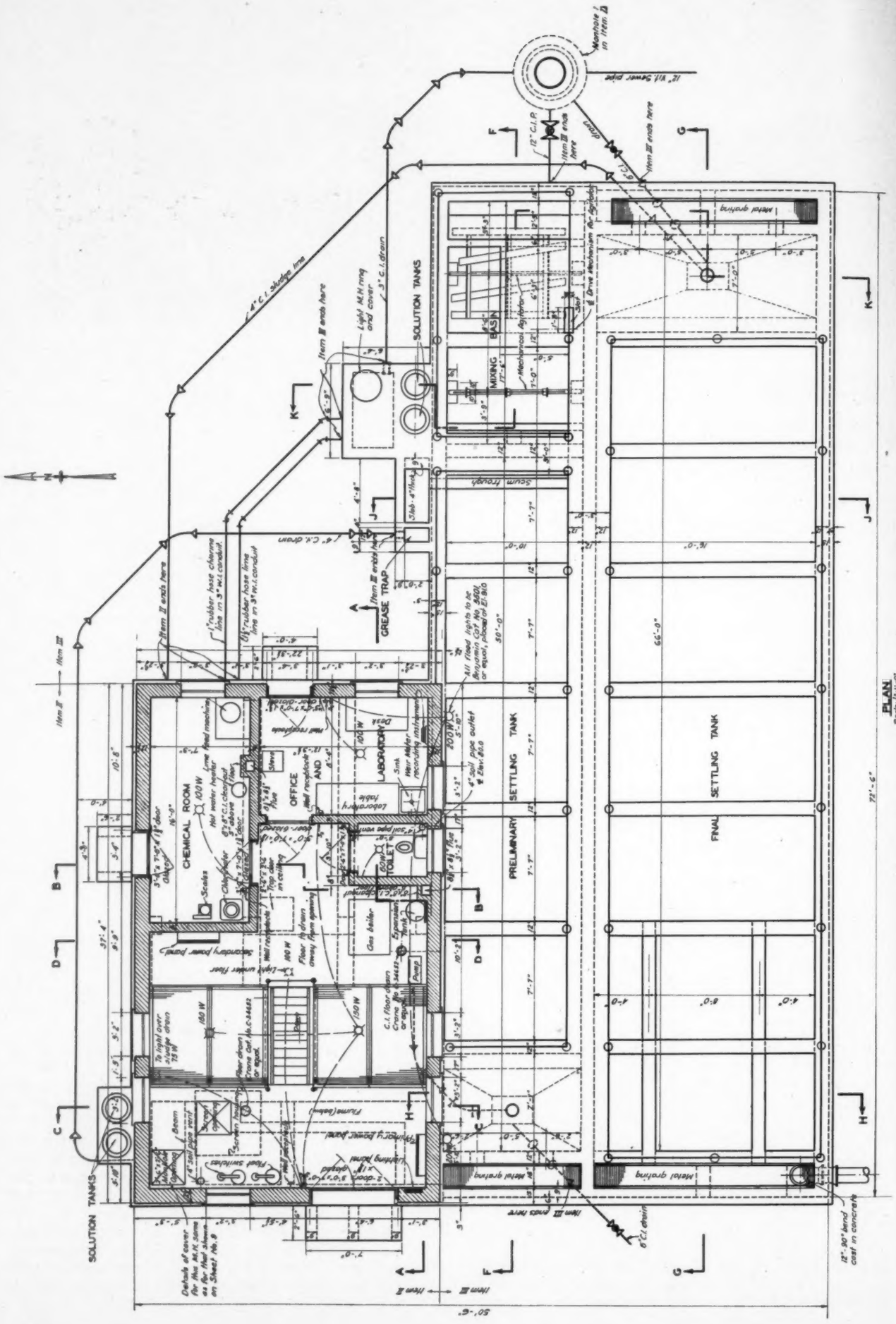


Fig. 1.—General Plan—Sewage Treatment Works, York, Neb.

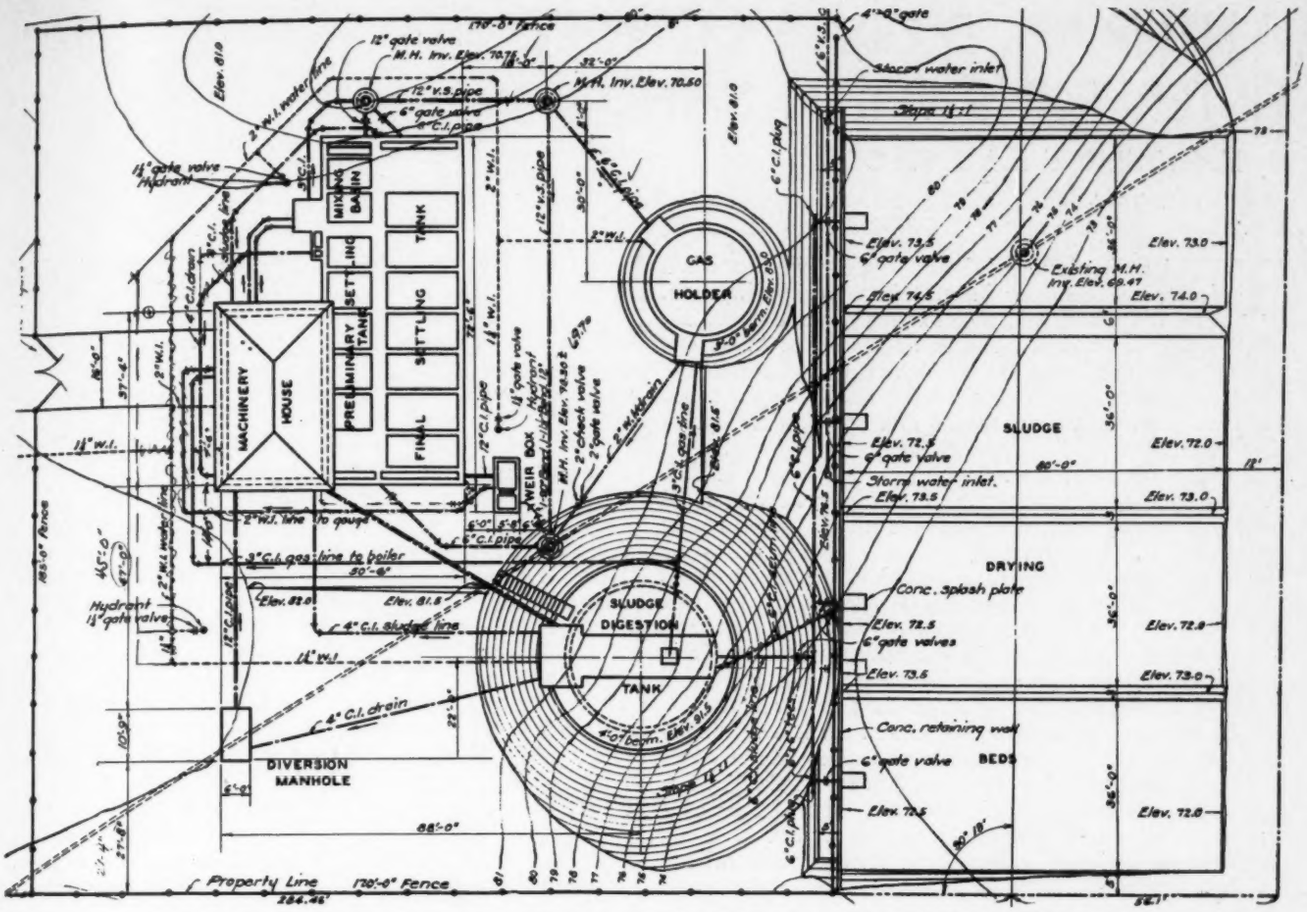


Fig. 2.—Arrangement of Tanks and Equipment—Chemical Sewage Treatment Works, York, Neb.

The plant is operated by one man who is on duty from 7:30 a. m. until 5:00 p. m. and chemicals are fed during this period only. Gaugings of the sewage flow indicated that slightly over 70 per cent of the sewage flow occurs during this period and it seems that sufficient coagulant is left in the system, from the day's run, to take care of the weaker night sewage.

Until recently, very little has been done in the way of plant tests and results are not yet sufficiently defined for publication. Numerous catch samples have retained the color of methylene blue for periods of from 12 to 24 hours, and the removal of settleable solids is practically complete. The effluent is, however, noticeably turbid when examined in a glass beaker, although this turbidity is not particularly noticeable in the stream bed.

Chemical Dosage

For the past four months, the chemical treatment has consisted of 120 pounds of ferric chloride (scrap iron plus chlorine), and 180 pounds of hydrated lime per million gallons fed during the period of attendance as stated above. This represents dosages of 82 pounds of ferric chloride and 122 pounds of lime per million gallons when sewage flow for entire day is considered.

The ferric chloride is produced at the plant by passing a chlorine solution from a chlorinator over scrap iron in reaction tanks formed of vitrified sewer tile set in concrete. Crushed tin cans from the near by city dump have proved to be entirely suitable for the purpose, and an adequate supply for a number of years' operation is available. A reasonable amount of supervision over the strength of the chlorine solution is necessary to insure the formation of *ferric* rather than *ferrous* chloride but, at this plant at least, it seems that as long as approximately 40 gallons of water are used per pound of chlorine, and if the reaction tanks are kept reasonably full of crushed cans, practically all of the chloride produced, is in the ferric form.

Costs

Due to the small size of the plant, chlorine must be purchased in 150 pound cylinders at approximately 10 cents per pound, and on this basis the ferric chloride costs approximately five cents per pound, exclusive of the labor for collecting and crushing the tin cans. The total cost of chemicals amount to approximately $5.50 per million gallons.

The cost of the plan, exclusive of engineering and land, was as follows:

Excavation	$ 2,030.00
Machinery house and equipment	20,706.50
Settling and mixing tanks	11,768.70
Digester	10,000.00
Gas holder	3,700.00
Yard piping, and miscellaneous structures including sludge beds	5,576.70
Fence	1,388.10
Total	$55,170.00

Contrary to expectations, no trouble whatever has been encountered in the digestion of the chemically precipitated sludge. The digester was heated with an auxiliary coal fired boiler for a period of 60 days, and gas production has ranged between 0.8 and 1 cubic foot per capita since January 1, 1935.

This plant was designed by and built under the supervision of Black & Veatch, Consulting Engineers, Kansas City, Mo. The Chambers Construction Company of Lincoln, Neb., was the general contractor, and the plant is being operated by W. L. Garner of York, Neb.

Fig. 1.—General Plan—Sewage Treatment Works, York, Neb.

ANTHRAFILT GIVES LONGER FILTER RUNS THAN SAND

By H. G. TURNER[1] and G. S. SCOTT[2]
State College, Pa.

THE length of run of filters between washings is a factor of economic interest in water purification. The writers have completed experiments to obtain quantitative data on the length of filter run to be expected with anthracite as compared to sand. While these experiments were conducted on a laboratory scale, the results anticipate the trends and approximate quantitative relations to be expected in actual practice.

The experimental filter arrangement is shown in Fig. 1. To carry out a run, the 10-gallon tank was filled with tap water and the stirrer started. The motor speed was 1725 r.p.m. and this was geared down by the arrangement shown to a paddle wheel speed of 60 r.p.m., equivalent to a peripheral velocity of 1.7 feet per second. A generous supply of red clay (particles approximately 5 microns in diameter) was kept in a beaker of water. After starting the stirrer, a gauged quantity of the red clay in suspension was poured into the 10-gallon tank, and then 60 cc. of a solution (0.5% strength) of sodium carbonate was added, as the water did not contain sufficient alkali to form a good alum floc at the concentrations used. The stirring was then continued for a period of from 15 to 30 minutes. Following this, 60 cc. of a 1 per cent solution of aluminum sulphate was added and the stirring continued for about 30 minutes. The water was then applied to the two filters simultaneously. The area of the sand filter was 10.7 square centimeters and of the anthracite filter, 10.9 square centimeters. The rates were carefully adjusted before the first test, and the adjustment was not changed throughout the entire series. The rate controller is shown in Fig. 1. A 10-gallon reserve tank, also connected with a paddle wheel stirrer making 10 r.p.m. (equivalent to 0.74 feet per second peripheral velocity) was filled and treated in a manner similar to that of the supply tank, and the supply tank filled from this reserve tank when empty.

The temperature of the water varied between 15 and 20 degrees Centigrade. According to Freundlich[1] the principal effect of temperature is due to its effect upon the viscosity of the water. The pH varied between 6.0 and 7.0, which was found previously to be associated with the most satisfactory floc under the conditions.

Determinations of turbidity were made photoelectrically. A light-tight box was constructed, containing a Weston Photronic Cell in one end and a 25-watt Mazda bulb in the other end, with a central compartment containing a battery jar of 1½ liters capacity, for holding the sample to be tested. The readings were made on a potentiometer. The outfit was standardized as follows: A sample of high turbidity was tested by the platinum rod method, then with the photoelectric outfit. This same sample was then diluted in steps and readings taken photoelectrically. From the results a relation was obtained between turbidity and electromotive force. To offset changes in line voltage, and variations in the light bulb with time, a duplicate battery jar, having photoelectric properties similar to those of the test jar, and containing sparkling clear water, was used as a control, and each test was checked against it. The absolute accuracy of the results depends, not only on the accuracy of the photoelectric procedure, but also on the accuracy of the platinum rod test on the standardizing sample. The relative accuracy was judged to be about one-half part per million, and was limited by the sensitivity of the potentiometer.

The filter media were treated as follows: From weighed cans, each filter tube was filled to a depth of 12 inches, and the weight used was determined by difference. The filters were then thoroughly backwashed. After backwashing, they were ready for the first run. At the end of the run, each filter was again thoroughly backwashed, without regard to the quantity of water used, and a check run made. Both filters were then emptied, and by the same procedure as before, one was filled with a fresh sample of sand (20×30 mesh, U. S.), and the other was filled with the size of crushed and graded anthracite to be tested.

The porosity of the filter medium was determined by computation from the measured depth at the beginning of each run, the weight of material used, its specific gravity, and the known volume occupied by the medium.

A run was considered complete when the loss of head reached four feet. The filtering rate employed

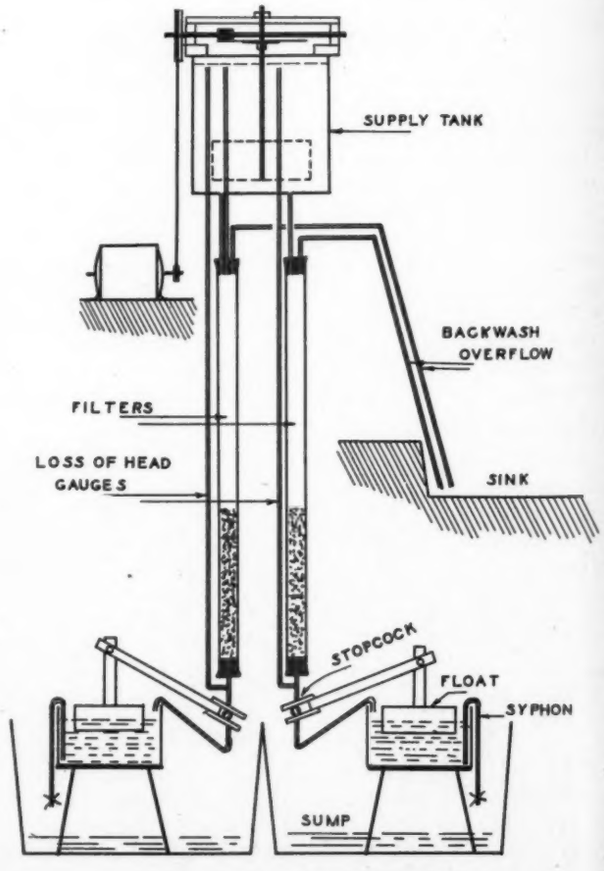


Fig. 1—Experimental Filters

(1) Director, and (2) Former Asst. Director of Research for the Anthracite Institute, The Pennsylvania State College, State College, Pa.

TABLE 1.—EXPERIMENTAL RESULTS

Ottawa Sand

Area of Filter = 10.7 cm.², sp.gr. = 2.65

Size (U. S. sieves)	Turbidity Appl.	Turbidity Eff.	Depth Bed cm.	Porosity %	Av. Hrs. of run at 125 mgad.	Hrs. Run at 20 ppm. A.T.
20x30m	23	3.0	34.3	43.6	14.13	16.25
20x30m	26	0.7	34.0	43.1	10.85	14.10
Average	..	1.8	....	43.3	.....	15.17
20x30	29	0.6	33.0	42.0	10.94	15.85
20x30	27	1.9	....	....	10.22	13.80
20x30	20	2.0	31.7	39.6	9.00	9.00
Average	..	1.5	....	40.8	.....	12.88
20x30	16	0.6	31.0	37.8	5.96	4.77
20x30	22	0.5	33.0	41.5	17.03	18.72
Average	..	0.5	....	39.6	.....	11.74
20x30	25	0	33.0	41.3	7.68	9.60
20x30	28	0	33.0	41.3	4.40	6.16
Average	..	0	....	41.3	....	7.88

Temperatures 15–22 deg. C.

Anthracite

Area of filter = 10.9 cm.², sp.gr. = 1.44

Size (U. S. sieves)	Turbidity Appl.	Turbidity Eff.	Depth Bed cm.	Porosity %	Av. Hrs. of run at 125 mgad.	Hrs. Run at 20 ppm. A.T.	Ratio Hrs. Anthr. to Hrs. Sand
25x35m	24	1.1	36.8	54.5	9.94	11.93	....
25x35m	26	0.6	36.3	54.0	13.64	17.73	....
Average	..	0.8	....	54.2	.....	14.83	0.98
20x30	29	0.3	34.6	54.8	13.43	19.46	....
20x30	25	1.5	....	....	14.95	18.70	....
20x30	21	0.7	34.3	54.3	10.60	11.13	....
Average	..	0.8	....	54.5	.....	16.43	1.27
18x25	17	0.4	36.9	53.4	14.95	12.71	....
18x25	19	1.3	39.6	56.7	31.46	29.90	....
Average	..	0.8	....	55.0	.....	21.30	1.81
16x20	27	0.2	38.1	55.0	15.86	21.42	....
16x20	24	0.1	35.8	52.1	10.40	12.48	....
Average	..	0.2	....	53.5	.....	16.95	2.15

pH of Effluent 6.0–7.0

was 100 gallons per square foot per hour. As the rate began to drop near the end of the run, the loss of head at a rate of 100 gallons per square foot per hour was calculated from the observed loss of head and the measured rate by direct proportion. Such a calculation has been shown by the work of Hulbert and Feben,[2] to be perfectly permissible.

Experimental Results

The experimental results are summarized in Table 1. In the 7th and 14th columns is given the number of hours of filter run at 20 p.p.m. applied turbidity. The figures in these two columns were calculated by direct proportion between 20 p.p.m. and the actual applied turbidity as measured, it being assumed here that little error would be introduced because of the small deviation between the applied turbidities and the base selected (20 p.p.m.). In column 15 is shown the ratio $\left[\frac{L_A}{L_S}\right]$ of length of filter run, for the four different sizes of anthracite tested, against the one size of sand (.61 mm.) used in all tests for comparison.

The same information as given in column 15 of Table 1 is shown plotted on Fig. 2, after reducing all tests to average porosities. The average porosity of the anthracite beds for all runs was 54.3 per cent, while the average porosity for all the sand beds was 41.2 per cent. From various considerations it was concluded: That the length of time required to clog a filter was, (a) inversely proportional to the area of exposed grain surface; (b) directly proportional to the distance between the grains; (c) directly proportional to the porosity; (d) inversely proportional to the surface of the floc particles.

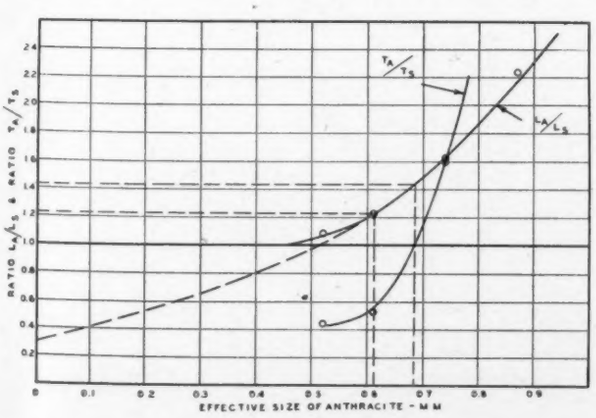


Fig. 2—Ratios of Length of Filter Runs Anthracite of Various Size Grains (See Column 15, Table 1)

Based upon these assumptions the following factor is derived:

$$\frac{(1 - P_A)\ P_S^{4/3}}{(1 - P_S)\ P_A^{4/3}}$$

for converting the above ratio to an equal porosity basis. In this formula [P_A] is the porosity of the anthracite bed, and [P_S] the porosity of the sand bed.

When the data from column 15 of Table 1 are multiplied by this factor we obtain Table 2.

TABLE 2

d (= e)	$\frac{L_A}{L_S} \times \frac{(1 - P_A)\ P_S^{4/3}}{(1 - P_S)\ P_A^{4/3}}$
0.53 mm.	0.586
0.61	0.653
0.74	0.872
0.87	1.205

The figures in Table 2 are now multiplied by the same expression except that the average porosities mentioned above (54.3 for anthracite, and 41.2 for sand) are now substituted in the factor $\frac{(1 - P_A)\ P_S^{4/3}}{(1 - P_S)\ P_A^{4/3}}$

After this correction is made we obtain Table 3.

TABLE 3

d (= e)	Corrected Ratio $\left[R = \frac{L_A}{L_S}\right]$
0.52 mm.	1.090
0.61	1.215
0.74	1.622
0.87	2.241

Comparison of Table 3 with column 15 of Table 1 will show that there is no large difference between the ratios given in these two tables so that the ratio is not changed to any great extent by theoretical considerations, the net result being merely to smooth out somewhat the figures as actually measured.

It should be especially noted that the same applied water was passed through both filters simultaneously and at the same rates. Since the actual length of filter run in terms of hours depends upon a number of factors, some of which are practically beyond control, it was felt, that in order to be of value, data on the length of filter run necessarily had to be comparative. Therefore, the material selected as a basis for comparison was well rounded standard Ottawa sand because of its

reproducibility and rather wide distribution commercially.

The average turbidities of the effluents are shown in Table 1 (columns 3 and 10). On Fig. 2 is shown the ratio $\left\{\frac{T_A}{T_S}\right\}$ of the turbidity of the effluent from the Anthrafilt to the turbidity of the effluent from the sand.

From Fig. 2 we may observe some interesting relationships: First, if we select an Anthrafilt of the same effective size as the Ottawa sand (.61 mm.), the Anthrafilt under identical conditions will give a filter run 1.23 times as long as the sand. Second, if we select a size of Anthrafilt which will give the same quality of effluent as the .61 mm. sand $\left\{\frac{T_A}{T_S} = 1\right\}$ the length of filter run for the Anthrafilt would be 1.45 times as long as the length of run with .61 mm. Ottawa sand. It will be observed that the effective size of the Anthrafilt in this second case would be .68 mm.

Summary

The lengths of filter runs of four different sizes of Anthrafilt with uniformity coefficients of 1.21 have been determined in comparison with runs through Ottawa sand of effective size 0.61 mm. and uniformity coefficient 1.21.

It has been shown by this study that Anthrafilt will give longer filter runs than sand of the same size and at the same time yield a better quality of effluent.

It has been shown also that Anthrafilt, larger in size than the standard sand selected, will give still longer filter runs while producing effluents of equal quality.

References

1. Freundlich, H.: Colloid and Capillary Chemistry. E. P. Dutton & Co. (1922), p. 448.
2. Hulbert and Feben: "Hydraulics of Rapid Filter Sand," J.A.W.W.A., Vol. 25, p. 19 (1933).

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Oklahoma Injects Novelty into Its Water and Sewage Short Course

The picture is that of a part of the group which attended the 11th Annual Oklahoma Water and Sewage Short Course held at Oklahoma A. & M. College at Stillwater, Okla., July 14th-19th.

An innovation introduced at this conference was, that formal "papers" were dispensed with in favor of informal talks, demonstrations, discussion and questioning. Professor E. R. Stapley, Field Engineering Consultant and Sanitary Engineering Instructor at Stillwater was in charge of the program.

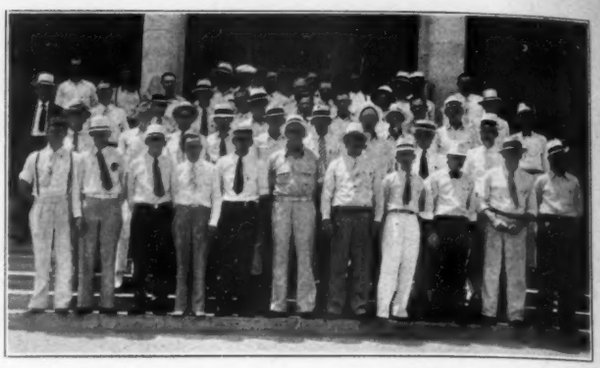
A featured innovation, introduced as one of the courses, was that of "job analysis" which included not alone the duties of operators but also the psychological side of handling employes and also that of "how to handle the boss." This particular course had an especial appeal. It was something new to water works and sewerage operators and will continue a part of future annual short courses.

It was voted to divide the State into four districts for the purpose of holding quarterly "easy to reach" meetings in each district, supplementing the annual conferences at Stillwater.

Officers elected for the ensuing year are:

President—E. L. Bickerstaff, Foss, Okla.

Vice President—V. E. Stockton, Stillwater, Okla.



Oklahoma Water and Sewage Conference Group—1935

Sec'y.-Treas.—H. J. Darcey, Oklahoma City, Okla.

Exec.-Comm.—E. M. Evans (Fairview) and L. F. Parks (Muskogee).

▼

Van Loan Made Chief

Seth M. Van Loan, for several years Deputy Chief of Philadelphia's Bureau of Water, has recently been made Chief of the Bureau which he has been instrumental in building up to its present state of efficiency.

▼

W. Palm Beach Served 'Gator Cocktails

When West Palm Beach, Fla., cleans its coagulation basins here are some of the things it finds at times. Besides removing b. Coli, and the like, the West Palm Beach plant serves as an "Alligator Trap." Here are a couple of specimens removed recently, which are no mere "tad-poles." Basin cleaning day is a great one for the kiddies. Admiring his dad's pets, is Keith Chrim, Jr., the young son of W. Palm Beach Water Co.'s Chemist in Charge of Filtration.

[Note:—Newspapers are warned not to use this copyrighted bit of comedy. "Alligator Cocktails" are not so bad if you don't have to eat the "cherry."]

MEETING OF THE CENTRAL STATES SECTION A. W. W. A.

THE Central States Section of the American Water Works Association (organized 1897, now 243 strong) held its 37th Annual Convention in Pittsburgh, Pa., on August 22nd and 23rd. Approximately 185 were in attendance.

Especial attention had been given by John E. O'Leary, Jas. H. Kennon and their committees to entertainment, the high-light of which was the evening at Pittsburgh's exclusive and picturesque Shannopin Country Club which is situated on one of the highest neighboring hills and overlooks the center of the city. Here golf on Shannopin's sporty course was followed by the cocktail hour and, thereafter, dinner and dancing to music rendered by Pittsburgh's best known orchestra. Between dinner and dancing, Professor Lewis V. Carpenter showed entertaining movies taken by him during the 1934 meeting, and at the Cincinnati Convention.

The afternoon of the second day was devoted to inspection trips to the three main pumping stations (Saline, Highland and Brilliant), and to the filtration plant at Aspinwall.

During the meeting, the recent death of a long-time member and Trustee, Geo. M. Keefer, of Rensselaer Valve Company, was announced and appropriate resolutions, lamenting the loss of this valued member, were drawn and passed. To fill his unexpired term as Trustee, Edw. A. Johnson of Pittsburgh Equitable Meter Company was appointed.

Officers elected for the ensuing year are:

Chairman—W. W. Morehouse, Supt. Water and Sewerage, Dayton, Ohio.

Vice-Chairman—Roberts Hurlbert, Sr., Chemist, Water Dept., Detroit, Mich.

Sec'y-Treas.—H. Lloyd Nelson, U. S. Cast Iron Pipe Co., Pittsburgh, Pa.

Trustees—T. L. Young, Mgr., Water Works, Chester, W. Va.; E. A. Johnson, Pittsburgh Equitable Meter Co., Pittsburgh, Pa. (Appointed to fill unexpired term of the late Geo. M. Keefer).

President Barbour and A.W.W.A.

Frank A. Barbour, President of A.W.W.A., was in attendance. Upon request of Chairman Lechner, he spoke concerning the activities of the parent association and complimented the Central States Section on its work and prowess. He felt that the recent growth in membership of A.W.W.A. was encouraging and that much could be done, through efforts of its present 2,800 members, to increase the membership to the 5,000 which it should be when considering the potential members connected with the more than 10,000 municipal water supplies of America. The successful membership drive started earlier in the year, he said, was to be continued. For this purpose Mr. Eastwood had been alloted $1,000 for the work of his committee for increasing membership. He spoke of the work of the important Committee on Water Works Practices and urged the Central States Section, along with others, to coöperate with Mr. Pirnie, chairman of this committee, in developing technical programs. Needed material for the revised edition of the A.W.W.A. Manual on Water Works Practices should thus be procured. The Publication Committee of the parent association, he said, was planning the 1936 A.W.W.A. Convention program also with the objective of procuring material for the Manual in mind.

B. J. Lechner, Secy.-Treas. Water Dept., Erie, Pa., Retiring Chairman

W. W. Morehouse, Supt. Water Works & Sewerage, Dayton, Ohio, Chairman Elect

Mr. Barbour urged sections in adjoining areas to consider the feasibility and practicability of scheduling their meetings on dates which would be contiguous, or as nearly so as practicable. This, for the convenience of many who find it desirable or necessary to attend the meetings of both sections. (Such a plan of coordination has been very effectively followed by the Virginia and the North Carolina Sections and by the Southeastern and the Florida Sections.—Ed.)

Looking into the question of extended activities of A. W. W. A. for the best interest of the water works profession, Mr. Barbour felt that more investigational work and research through special committees, such as the recently named Committee on Steel Plate Pipes, would prove decidedly worthy of the expense when more funds became available. An increase in members was badly needed to provide the necessary income in the form of dues to finance such a program, and the value of the association to its members would consequently advance with an increase in new members. Another highly important and profitable undertaking which he felt should be put into effect through A. W. W. A., was that of determining and prosecuting methods which will bring before the general public the true value of the local water works utility and the men responsible for their management and operation. If the public was effectively sold on what public water supply represented to the community and the relative inexpensiveness of the service and the commodity, considerable benefit would accrue to the water works fraternity. With increased income such a campaign could and should be conducted by A. W. W. A.

Technical Sessions

(Chairman B. J. Lechner—presiding.)

In line with effective publicity advocated by President Barbour in order to strengthen good-will and improve public relations in water utility operation, a highlight on the program was the moving picture—"Behind the Water Front"—prepared for public showings, and for such effectively used by the Indianapolis Water Company. Accompanying the showing, Miller Hamilton, Public Relations Director of the Indianapolis Water Company, presented the style of non-technical talk which is made (with modifications) before various types of audiences. He said that this and other types of publicity had thoroughly justified the expense in procuring

Frank A. Barbour, Boston, Mass., President of A. W. W. A. Said He found the C. S. Section Hitting on All Cylinders

Miller Hamilton, Indianapolis Water Co., Sells Indianapolis Citizens on the Value of Their Water Works

a better understanding between the utility and its customers. The film which was prepared under Mr. Hamilton's direction showed the result of what an "outsider" can accomplish by injection of romance into the highly practical aspect of a municipal water supply, and the resultant appeal to the lay mind. Some of Mr. Hamilton's interesting comments were these: Taking the whole of the planet on which we live, during each of the 1,440 minutes of every day at least 96,000,000 tons of water in the form of rain or snow falls to the earth's surface. Indianapolis was the least favored city of its size of any in the world when it came to the natural facilities of water supply. Its source of supply (White River) was the most limited natural supply of any city of equal size. The Indianapolis Water Company, established in 1869, had bought from bankrupt Indiana its State Canal in order to secure a dependable source of water supply. With 659 miles of water mains the rate of extension prior to the depression had been 25 miles of new mains per year—now but 2.5 miles per year. The animated travel a pipe line, making its way from Indianapolis over the mountains to New York City and out into the Atlantic, constituted an impressive picturization of Indianapolis' mileage of mains. Meters on 77,000 services had to be tested at intervals not exceeding 8 years, and more frequently when conditions warranted. The purification plants covered 130 acres, and the extensive laboratories, considered "the brains of the plant," tested 50,000 water samples annually to protect consumers. At this rate a sample was examined each 10.5 seconds.

To provide adequate fire protection 33 per cent of the capital invested in equipment of the water utility represented an added requirement for this important function. Indianapolis, as a consequence of the efficiency of its water supply and fire fighting facilities, boasted the lowest basic fire insurance rating of any American city of 100,000 population or larger. All of this involved added investments by the water utility, resulting in unheralded benefits to Indianapolis citizens.

"Modern Methods of Control of Electrically Operated Pumping Stations"—By S. A. CANARIIS, Engineer, Water Department, Pittsburgh, Pa.

Mr. Canariis in reviewing the modern methods of remote and automatic control pump operation, employed in four of Pittsburgh's pumping stations, called attention to the dependability and exactness of such control by present day mechanisms. Even earlier had these proven their merit in control of power station operations. As the result of his experiences with remote supervisory control of pumping stations, he looked for a more widespread adoption of the highly dependable non-manual types of control, of scattered stations, from a central or master station. More exact and uniform control of main pressures and available water in high pressure storage, at less operating cost, could be had thereby.

In general "Supervisory Control Systems" which involved the use of a two-wire telephone circuit, good for long or short distances, was preferable to "Direct Wire Remote Control" which involved many wires and a special cable system. Likewise, the "visible" type of supervisory control, even at its somewhat initial cost, was to be preferred to the "audible" system involving the sending out of dot and dash code signals to and from the station to change, or to reveal, operating conditions to the remote supervisor. The visible method involved a system of switches, lights and push buttons. At all times operating conditions could be seen at a glance. Much quicker and positive changes were possible than could be had by use of the slower audible system requiring double checking of code signals, alarm equipment, etc. Mr. Canariis briefly explained the visible system installed for attaining remote supervisory control of Pittsburgh's newest (Saline) pumping station, delivering into the highest areas of a district heretofore difficult to adequately serve because of a deficient distribution system. A visit to the Saline station constituted a part of the inspection trip on the following day. There, the visible control system, which had paid for itself through the reduction of operating costs during the first year, was demonstrated.

Stations automatically controlled to maintain water elevations in reservoirs or tanks between definite levels involved the use of diaphragm operated mercury switches which were capable of recognizing as little as a 6 inch head differential. To preclude the effect of surge and thereby unnecessary operation of motor control equipment, a thermal relay, in which the heater element is controlled by the pressure relay, is interposed. The bi-metal arm actuates the control switch only after a delay sufficient for the surge effect to have passed. Where direct pressure was not dependable a rented telephone wire was being used to transmit pressure relay to a thermal relay at the Lincoln Pumping Station and thereby cause a change in the pumping rate within two minutes. If a sudden line pressure drop persists for more than two minutes a pressure relay

Attending the Central States Meeting

From the Left: Ed. Eyler (Pittsburgh), Jim Dunwoody (Erie), Paul McNutt (Toledo), J. D. Johnson (Erie), Earl Johnson (Pittsburgh), Fred Durner (Cleveland), C. S. Hetrick (Oil City, Pa.)

operates the thermal relay and cuts in the required additional pumps.

Mr. Canariis in commenting further, called attention to the value of electrically controlled hydraulic rotary type valves on pump discharge lines, which opened and closed automatically with the starting and stopping of pump motors. For emergency protection, electrically operated gate valves had been placed in series with the rotary valves at the large capacity Brilliant station. In the new Saline pumping station (230 lbs. operating head) hydraulically operated rotary type cone valves had been used in series with electric cone type valves as a safeguard against possible temporary power failures. The hydraulic cone valves had not been difficult to adjust for proper time of opening and closing to preclude surge or "water-hammer," and had operated satisfactorily against 230 lb. head on 65 pounds of water pressure. Low pressure allowed a coarser setting of ports in the operating mechanism and, thereby, less rapid changes in speed and also smoother valve operation had been secured.

On the whole present day standardized automatic control equipment appealed to Mr. Canariis as being more dependable and economical, and would recognize changed operating conditions more quickly and accurately than could even the best trained operators. The dependability of remote control of operation, he pointed out, had changed the picture of economy of steam as against electrically operated stations. The possibilities of remote control and central station control offered a variety of applications not yet fully appreciated.

D. R. Davis, Consulting Engineer, Pittsburgh, Pa., told of the use of automatic control in the operation of the booster station on the Erie, Pa., system, involving exact pressure maintenance by use of variable speed motors on the pumps. He also referred to the alternate, and probably more economical, method which by automatic switchboard control the combination of various fixed speed constant capacity motor pump units in service were varied to meet varying demands and avoid major pressure fluctuations. Like Mr. Canariis, Mr. Davis looks for a growing adaptation of automatic and remote or central station control of pumping stations as the result of the dependability and economy of modern central equipment.

"Diversified Electric Utility Rates and Their Possible Application to Water Rates"—By Nathan B. Jacobs, Consulting Engineer, Pittsburgh, Pa.

Mr. Jacobs' paper was read by F. C. Foote, a member of the firm. Mr. Jacobs' paper set forth the three basic methods employed by electric utilities in setting up schedules of rates. It also told of various and complex methods used, which added confusion to the basic principle of a readiness to serve charge plus a sliding scale charge (block rate) on the metered consumption. This last was the simplest of the methods and was the scheme employed generally by water utilities. After a study of the situation in the electric field and the water field it had to be concluded that the simple and clean-cut method of rate structure was the most desirable and commendable. No reason appeared to justify any attempt to change the basic pattern with an idea of gaining thereby. In the water utility field Mr. Jacobs had found that no effort of consequence had been made to increase sales of water by offering promotional or off peak rates as had been followed in the power field.

George Keefer at His Last C. S. Convention. The Above Snapshot Was Taken During the 1934 Convention of the Section at Wheeling, W. Va. George Keefer (Right) Would Have Attended His 30th Convention of the Cen. States Section at Pittsburgh, But for His Sudden Death Shortly Before. He Was a Valued Member of the Executive Board of the Section.

G. W. Knight, Manager, Natrona (Pa.) Water Company spoke in support of the readiness to serve (demand) charge as an essential fixed rate to insure a partial return on the invested capital in equipment required to meet maximum demands and provide the service expected. It was to him the fairest method of covering interest costs.

S. A. Canariis said that, to his mind, power companies were not justified in requiring a demand charge from pumping stations because of their rather constant power consumption during each day of every year, regardless of changing economic conditions. Unlike factories and mills, water works' consumption of power did not fluctuate greatly. He felt that the A. W. W. A. would be undertaking a valued and justifiable service in sponsoring a movement toward getting demand charges to pumping stations modified, if not eliminated completely.

D. E. Davis agreed with Mr. Canariis when it came to the larger stations but in smaller ones he believed the load variations were sufficient to justify the demand charge.

F. C. Foote called attention to the possibilities of pumping cost reduction where storage allowed the use

Snapped at the Central States Meeting

Left to Right: John Brunner (Harrisburg), G. W. Knight, (Natrona, Pa.), Mentor Hetzer (Moundsville, W. Va.), Chas. W. Kunkle (Johnstown, Pa.), John Gettrust (Akron, O.), E. E. Bankson (Pittsburgh), C. E. Inman (Warren, O.)

Jas. H. Kennon, Engr. & Manager Pittsburgh's Water Dept., Chairman Convention Committee

Jack O'Leary (Pittsburgh-Des Moines Steel Co.) Had Charge of Entertainment; Did a Swell Job

of the much cheaper off-peak power for pumping during off-peak periods. He agreed that power companies had in general overlooked the true value of pump station loads. Some, however, had established special pumping rates of a favorable nature.

"Some Experiments With Model Overfall Dams in a Study of Erosion Prevention" by GALE DIXON, Consulting Engineer, Youngstown, Ohio.

Mr. Dixon in a talk, illustrated by moving pictures, told of work on model overfall dams, constructed to scale and operated under his direction, in a study of erosion effects at the base of such dams and methods of correction. The several schemes tested were pictured and the good and bad features explained. In the final analysis, reliance on the hydraulic-jump, preceded by a special "break-apron" of his own design at the foot of a weir type dam, proved to be the method preferred. This "break-apron" merging into the face of the dam on a flattened slope seemed to cause the spill to glide into the jump and turn over on itself most effectively.

Water Treatment Topics

"Water Works Experiences from the Viewpoint of a Health Official" by H. E. MOSES, Assistant Chief Engineer, Pennsylvania Department of Health, Harrisburg, Pa.

Mr. Moses presented an analytical review of experiences and modern trends in water quality control. He stressed the fact that water borne typhoid was only a *controlled* disease and not one which had been eliminated. In arguing the importance of constant need of reliable undiminished efficiency in water purification practice, he pointed to the fact that surveys had revealed that 21 per cent of all outbreaks of water borne diseases in recent years had been chargeable to failures in purification processes relied upon for protection. Chlorination processes had come to be considered an essential part in the control of water borne disease, and perfection and better understanding of chlorination control measures had constituted a notable advance. It had become almost axiomatic to say that "No public water supply could be considered at all times safe without chlorination." He felt, however, that chlorination had been such an effective method of rendering water safe that it was in some instances too greatly relied upon and that there had been too great a let-down in attention to the accompanying filtration process.

Mr. Moses referred to the trend in public demand for improved water quality and the growth of taste control measures, iron removal, softening and control of corrosion. Realization of the value of good public relations was resulting in marked attention to the production of water free of objectional tastes and odors—also to the psychological aspect of plant beautification, and "good-housekeeping" within. Likewise there had been a commendable growth in research aimed at the production of better water and noticeable was the trend toward improving service and building "good-will" for the water utility, rather than cutting operating costs at the expense of producing a product and service of only passable quality. Mr. Moses' talk was of a nature to incite a desire in water works operators to keep step with the modern trend in improvements of plant, in personnel appearance and in quality of product and service. That is, to make the water supply the No. 1 utility in every respect, as it should be.

"Experiences in Treating the Monongahela River Water" by F. W. BOUSON, Superintendent Filtration, South Pittsburgh Water Company, Pittsburgh, Pa.

Mr. Bouson's paper dealt with the problems of treatment of a raw water containing soluble iron, alumina and free sulphuric acid contributed as coal mine discharge and from steel mill operations. Incrustants at times amounted to 500 parts per million and the quality fluctuated rapidly at times. The treatment required close supervision with half-hourly control tests made to properly adjust the neutralization of the "free" acid with soda-ash (following aeration) and thereafter softening with lime and soda-ash to reduce the hardness to between 90 and 100 parts. Recarbonation had replaced split treatment as being more dependable in effecting reduction of the carbonate alkalinity of the softened water. Full use was being made of the natural coagulating elements (iron and alumina) in the raw water which were frequently equivalent in content to 10 grains per gal. of filter alum.

In regulating coagulation exact pH. control, to avoid colloidal or soluble alumina choking filters and appearing in the effluent, had proved of paramount importance in reducing mud ball troubles and frequency of filter bed renewal—now, every 5 years as against every year previously. Minimum residual alumina (1 p.p.m. Al_2O_3) and iron in the effluent was had at pH. values of 6.8 to 6.9 maintained in the applied water. An interesting observation in coagulation and pH control had shown that the practice of filtering test samples through absorbent cotton (of high quality) had resulted in an error due to the acidity of the cotton. In this practice he wished to warn operators to discard the first portions of the filtrate when employing the otherwise satisfactory cotton filtration scheme.

In taste control it had been observed that as the pH. value of the water increased above 7.0 taste production resulting from chlorination had been more pronounced. Frequently chlorination of the raw water had produced no tastes whereas after lime additions tastes had been pronounced. Fortunately, at pH. 6.9, for best filtration, the resulting taste production was at a minimum.

Secondary lime application to the effluent for corro-

On the program:

F. W. Bouson, Chemist, So. Pittsburgh Water Co.
F. C. Foote, Consulting Engr., Pittsburgh
S. A. Carnariis, Engr. Pittsburgh Water Dept.

sion control had disclosed the fact that at pH. 8.3 the filtered water picked up iron from the mains accompanied by a pH. drop to 7.6 during its travel through the distribution system. Corrosion appeared to be held to a minimum when adjustment of filtrate to pH. 7.3 was practiced and, therefore, this value had been selected as optimum for plant operation. For most effective overall taste control, powdered "Nuchar" had been added to the water entering the filters in order to remove the residual taste producing elements, which appeared to be colloidal in their nature.

PROFESSOR LEWIS V. CARPENTER commented that his experienced in coagulating waters had revealed that the pH. values productive of most economical coagulation, with alum, was higher than that productive of a more efficient coagulation. For example, pH. of 6.9 for economy as against 6.2 for the highest removal of the alumina present. He was of the opinion that efficient coagulation would eliminate the major filter bed troubles which had caused advocacy of extremely high velocity washes and other remedies. Rather than attacking the effect, the cause might be largely eliminated by more attention to coagulation.

L. H. ENSLOW said that the experiences reported by Mr. Bouson in controlling corrosion constituted another case proving that quality of water was all important in securing control by pH. adjustment. He did not believe that a blanket "prescription" could be written which would effectively cure the conditions at all locations. Therefore, it remained necessary to demonstrate by actual trial what pH. value would prove most effective and economical. In general, as hardness increased the pH. required would decrease.

Mr. Bouson again stressed the effect of high pH. values in increasing taste production and the relief obtainable by chlorination at pH. values of 7.2 and less.

"Disinfection by Chlorine" by PROFESSOR W. L. MALLMAN, Michigan State College, East Lansing, Mich.

Professor Mallman in reporting on laboratory studies involving the several more important basic factors affecting chlorination efficiency in the destruction of bacteria, stated that, so far, chlorination was to be considered the most dependable, practical and economical of all known methods of rendering waters and sewage bacterially safe. Chlorination, after comparison with other known methods, had shown its superiority only when the several factors affecting its efficiency were recognized and taken into consideration. Therefore, it was pertinent to discuss these factors for a clearer understanding.

Among the most important factors affecting the speed of chlorine action had been the alkalinity of the liquid chlorinated. At high pH. values the suppressed ionization of the chlorine compound (its availability) markedly reduced the rate of bacterial reductions.. For instance, at pH. 5.0 residual chlorine values of 0.2 p.p.m.

On the program:

H. E. Moses, Asst. Chief Engr., Pa. Dept. of Health
W. L. Mallman, Professor, Mich. State College
L. V. Carpenter, Professor, Univ. of W. Va.*

**Director A. W. W. A. from the Section*

had after 10 minute contact produced results equivalent to a 20 minute contact at pH. 7.0. And, at pH. 8.0 more than an hour had been required to produce the same degree of sterilization. In general, it was to be concluded that the higher the pH. value the greater would be the residual chlorine required to effect equivalent results in efficiency and rate of sterilization. (See also what Bouson had to say, elsewhere in this report, concerning pH. values and their effect on taste production following chlorination—Ed.)

The time factor was also of considerable importance because a small residual with ample time of contact would produce results superior to higher residuals during short contact under practical operating conditions. It was true, however, that in lieu of longer contact an increased residual chlorine had proved as effective. Increasing contents of organic matter (chlorine demand) or turbidity; numbers of organisms per c.c.; reduced temperature; increased pH value, or ammonia—all had to be compensated for by increased contact period or increased chlorine dosages to maintain higher residuals, or both.

Dr. Mallman showed many lantern slide curves to illustrate the rate of b. coli and streptococci destruction in swimming pools and concluded that liquid chlorine was the most effective agent for practical use and the maintenance of pH. at 7.0 or under was important in procuring the highest protection of bathers. With ordinary chlorination 0.3 to 0.6 p.p.m. residual carried in the pool had proven ample. When ammonia chlorine treatment was involved the ammonia dosage should be held at the lowest ratio to chlorine proving effective, and higher residuals (up to double the 0.3 to 0.6) would be required for equivalent protection of bathers.

In estimating residual chlorine, Dr. Mallman felt that the ortho-tolidin test remained supreme. Titration, of liberated iodine, frequently gave a false impression because absorbed or loosely bound chlorine present would be recorded. The action of such chlorine was too mild and slow to be considered of practical merit and there-

Snapped at Shannopin Country Club

Lawrence, Harley, Braidech, La Due, Brunner—The Clubhouse—Davis, Blank, Carpenter, Nelson (Secy.)—the Sporty Course on the Ridge

W. R. La Due, Akron, Ohio, (Trustee of Section). They Like a "Super" With a Smile Like His

Chas. L. Fox, Wilkinsburg, Pa., Pres. Pa. Water Operators Assn.

fore only the so-called "free" chlorine (that quickly available) should be considered. This the ortho-tolidin test revealed and not the first.

In commenting on the ammonia-chlorine treatment in comparison with ordinary chlorination, Dr. Mallman felt that the chief value of the first was to be found after long contact and therefore was particularly important in effecting desirable conditions at remote points on distribution systems. Chlorine itself had been found to be 123 times more germicidal than chloramines, on short contact, but equal after 2 hours. As the quantity of ammonia had been reduced (5 chlorine to 1 ammonia) the process became almost equal to chlorination alone in respect to speed of kill and required residual. In taste control there was naturally a limit to the point to which the ammonia could be reduced and a balancing of taste prevention against efficiency of sterilization would have to be considered in practice. An interesting disclosure in pool studies, and also laboratory studies, had shown that with equal residuals as the pH. of the water increased the observed speed of kill by simple chlorination and that of ammonia-chlorination became much more nearly equal. The same corrective could be applied in either instance, viz.: the carrying of higher residual chlorine.

Open Forum

The meeting closed with an "Open Forum" conducted by Professor L. V. Carpenter, in which topics for the discussion had been selected by members in advance. Various members were called upon to answer questions and give their experiences with problems of the same or similar nature. Out of the discussions little that is new was forthcoming and there was sparse enthusiasm for standardization of markings (painting) of fire-hydrants. One member suggested, however, that regardless of the markings used the hydrant evaluation survey would at least prove valuable in revealing the true condition of the distribution system and hydrants.

"Sterilization of Mains," "Effect of Air Conditioning on Water Consumption," "Service Shut-Off Policies and Practices," "Emergency Crew Service on Distribution" and "Frequency of Meter Testing" were other topics discussed without producing "news."

The 1936 convention is to be held in Cleveland, Ohio.

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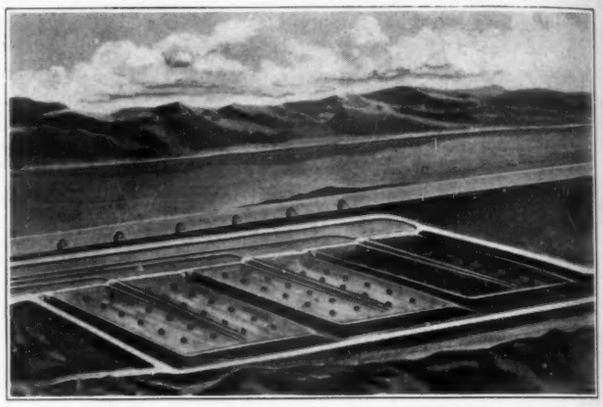
World's Largest Water Treatment Plant Will Desilt Colorado River Water

50,000 Tons of Silt To Be Removed Daily from 8,000,000,000 Gallons of Water

Almost 8 billion gallons a day of Colorado River water are to be desilted at what will be the world's largest water treatment plant. It will be located 15 miles northeast of Yuma, Ariz., at the Imperial Dam, which is about 250 miles below the Boulder Dam. The desilted water will flow 210 miles through the new All-American Canal to irrigate about 1,000,000 acres of arid land in California. The solid matter removed will at times be close to 70,000 tons of silt a day and the average about 50,000 tons. This vast project is being undertaken by the Bureau of Reclamation of the Department of the Interior and will take about two years to complete at a cost of about $38,500,000.

The flow of 8 billion gallons per day to be handled is 80 times that of the next largest mechanical water purification plant in this country, the 100 million gallon a day plant at Kansas City, Mo. This indicates the magnitude of the Colorado River Desilting Project.

During periods of high turbidity the water entering the desilting plant will contain 0.28 per cent (2,800 p.p.m.) of suspended silt by weight, equivalent to



Artist's Sketch of the Colorado River Plant

90,000 tons of silt per day. To prevent deposition in the canal, only 78 per cent of the silt (that coarser than a 270 mesh standard screen)—will be removed. This, it is estimated, will amount to about 70,000 tons per day and will be returned to the river below the canal intake. At a unit weight of 86 lbs. per cubic foot, this represents, in volume, 1,640,000 cubic feet a day. If spread on 38 acres of level land it would build up at the rate of about 30 feet each month.

The plant was designed by the Reclamation Bureau's engineers with the collaboration of the research and engineering staffs of the Dorr Company, Inc., who will supply the mechanical clarifier mechanisms for the plant. The design is the result of six years of field study supplemented by research and development work on both a laboratory and semi-commercial scale by the Bureau and Dorr Co.'s staff.

The desilting plant will consist of six very large settling basins, each approximately 769 ft. long, 269 ft. wide with an average depth of 14 ft., and arranged in pairs. Each pair of settling basins will be fed by an influent channel, located between adjacent basins. The flow will be from the center and across, rather than lengthwise of the basins. These basins will be equipped with 72 "Dorrco" mechanically operated clarifiers (125 ft. in diameter each) which are being especially designed for this project by the Dorr Company, Inc.

The construction and operation of this project is under the jurisdiction of the Denver, Colo., office of the Federal Bureau of Reclamation, R. F. Walter, Chief Engineer, and J. L. Savage, Chief designing engineer. The plans developed by the Reclamation Bureau engineers were reviewed by a board of consulting engineers consisting of Charles P. Berkey, Dr. W. F. Durand and Dr. Louis C. Hill.

"TEGUL": A NEW SULPHUR JOINTING COMPOUND FOR BELL AND SPIGOT PIPE

By C. R. PAYNE
Research Chemist, Atlas Mineral Products Co.
Mertztown, Pa.

C. R. Payne

SULPHUR has been used as a sealing or bonding agent for many years. It was first used to set iron hand rails in stone. A bonding agent of increased strength and improved physical characteristics was produced by incorporating into molten sulphur such materials as coke, sand or shale. Because of their ease of application and strength these sulphur cements have found many uses in industry. The use of sulphur cements to join cast-iron bell and spigot water mains has been described by Robinson.[1] Acid pickling tanks, sewers, and other structures subjected to the action of acids have been constructed of acid-proof brick jointed with sulphur cements and they are giving excellent service.

The influence of the size of the particles and percentage of voids within the aggregate upon the tensile strength of sulphur cements was studied at the Mellon Institute of Industrial Research.[2] The strongest cement was obtained by mixing 40 per cent of sulphur with 60 per cent of a sand with 32.5 per cent voids, but such a cement is stiff and pasty and is, therefore, not suitable for commercial work. In practice a balance must be struck, wherein maximum strength is obtained with proper fluidity or workability of the mix. This is accomplished by using more than 40 per cent of sulphur. All factors that influence the workability of sulphur cements have not been definitely ascertained, but the surface characteristics of the various aggregates are known to be of importance. Some surfaces are more easily wetted and bonded than others, but these surface effects may be modified by the addition of materials to the sulphur to change its surface tension, contact angle, and its ability to wet various surfaces.

Tegul Plastic Sulphur Cements

"Tegul" plastic sulphur cements were developed by the Mellon Institute of Industrial Research. The physical characteristics of these compounds and their method of fabrication have been recently described by Duecker.[2] The plasticizing agent used in these cements is an olefine polysulphide and with its aid it is possible to produce cements of varying plasticity. These plastics were given the name "Tegul" and have served as a basis for the development of a new class of materials. Cements made from Tegul, plastic sulphur, possess greater bonding strength and are many times more resistant to mechanical and thermal shock than ordinary sulphur compounds. The result of incorporating these new physical characteristics into sulphur cements is to produce a material having many valuable properties for bell and spigot pipe jointing. For instance, the initial leakage from joints poured with Tegul-Cements has proved to be much less than those poured with ordinary sulphur mixtures. The slight plasticity of the compound and its high resistance to mechanical shock is of value in pipe lines which are subjected to vibrations or to stresses caused by settlement in the line. The resistance of Tegul to thermal shock is of importance when used in jointing mains which are exposed to sudden changes in temperature or those which are carriers of hot water. The permanence, or life, of Tegul is well illustrated by the accelerated test described by Duecker in which bars of cement were subjected for 5 minutes to hot water (84 deg. C.) and then immediately plunged into ice water for 5 minutes. After 12 such heat treatments ordinary sulphur cements became so weakened that they could be broken by hand. Tegul sulphur cements retained 50 per cent or more of their original tensile strength even after being subjected to 20 such heat treatments. Tegul sulphur cements are not attacked by sulphuric or hydrochloric acids, and are resistant to 40 per cent nitric acid and many other corrosive liquids.

Sulphur cements have been used successfully for many years as jointing compounds for bell and spigot water mains. These joints usually leak when pressure is first applied on the line but this leakage steadily decreases until in time a dry joint is obtained.[3] Some engineers object, however, to back filling over water lines that are still leaking, even though they realize that in time the joints "take-up" and become dry. To leave the trenches open, until the joints cease leaking, delays the completion of the construction and often presents a traffic problem.

Leakage Tests on Bell and Spigot Joints Poured with Tegul

Numerous experiments were made in which test sections of bell and spigot pipe were joined with Tegul sulphur cement, the physical characteristics of which are listed in Table I. The test section of pipe was 12 inches

Jointing a 16-in. Main with the New "Tegul" Sulphur-Cement at Plainfield, N. J.

TABLE I.—PHYSICAL CHARACTERISTICS OF TEGUL SULPHUR CEMENTS

Tensile strength, figure-eight briquet 1x1 in. section, lbs. per sq. in.	600
Modulus of Rupture, lbs. per sq. in.	1,738
Compression test, cylinder 2x4 in., lbs. per sq. in.	5,562
Coefficient of expansion	15×10^{-6}

TABLE II.—LEAKAGE TESTS ON JOINTS POURED WITH TEGUL SULPHUR CEMENTS

Time in Days	Diameter of Pipe (inches)	Total Leakage from 5 Joints per Day (gallons)	Leakage in Gal. per Day per In. Diameter per Mile*
1	12	1.44	10.56
3	12	none	none

*Calculated on basis of 440 joints to the mile.

in diameter and contained five joints which were tested on the same day that they were poured. The various sections were tested under pressures ranging from 35 to 100 lbs. per sq. in., and the leakage determined. Results from one of these tests (listed in Table II) is typical. The average initial leakage of all of the joints poured with Tegul sulphur cements was 1/25th that of joints poured with ordinary sulphur compounds. As shown in Table II, the slight initial leakage that did occur in the Tegul joints had entirely stopped in two or three days.

Commercial Installations

The first commercial installation using Tegul sulphur cement was on an 8-inch water main at Lynchburg, Va. The pressure was built up to 115 pounds per square inch without any leakage at all taking place at any of the joints.

The second commercial installation, using Tegul-Cement has just been completed at Plainfield, N. J. It consists of 2,200 feet of 16-in. bell and spigot pipe on which leakage tests have not at this writing been completed. None of the exposed joints, however, have shown any leakage.

Summary

Results from numerous laboratory, shop and field tests and from commercial installations show that initial leakage is no longer a problem if Tegul sulphur cements are used to join bell and spigot pipe. In addition to meeting a demand for a jointing compound which is free from initial leakage, or practically so, Tegul sulphur cements possess greater resistance to mechanical and thermal shock, greater plasticity and a lower coefficient of expansion than do sulphur cements heretofore utilized in pipe jointing practice. All of these properties add practical value to a jointing compound.

Acknowledgement.—The writer is indebted to Mr. R. F. Wagner, Chief Engineer of the Water Department, Lynchburg, Va., and to Mr. George Haskew, Chief Engineer of the Plainfield Union Water Company, Plainfield, N. J., for the information supplied on the two installations referred to in this paper.

LITERATURE CITED

(1) Robinson, D. W., Southwest Water Works J., May, 1932, p. 17.
(2) Duecker, W. W., Chem. and Met. Eng., 41, 583-6 (1934).
(3) Prior, John C., Ohio State Engineering Experiment Station Bulletin No. 87, January, 1935.

Water Requirements of Apartment Houses

By W. M. RAPP

Superintendent of Distribution, Atlanta, Ga.

In connection with two Federal P.W.A. Housing Projects, in Atlanta, Ga., the matter of expected water requirements per apartment and per tenant, the size of tap, size of meter and service line, size of risers in the buildings and peak rates of demand expected were amongst those questions which required an answer.

From a study of apartment house statistics by survey and water consumption, and through carefully kept meter records on a selected number of representative apartment houses during an entire 12 month period, the Atlanta Water Department was able to supply some of the needed information.

For the enlightenment of any who may wish to know what to expect in the way of apartment house demands the data collected is here presented in summary form. Other data sheets on file in the Atlanta Water Department reveal the consumption for each apartment house during each month of the year.

APARTMENT HOUSE WATER SERVICE DATA
From Atlanta Water Works Records—1934

Size of Tap	Size of Riser	Style of Toilet	No. of Apts.	*Average Occupants	Avg. Daily Cubic Ft. Used	Av. Daily Per Capita Consd. Cu.Ft.	Av. Daily Per Capita Consd. Gals.	Static Pressure at Street
1-in.	1-in.	Tank	6	18	186	10.33	77.5	38
1-in.	1-in.	Tank	9	27	174	6.44	48.3	32
1½-in.	1½-in.	Tank	16	48	419	8.73	65.5	32
1½-in.	1½-in.	Flushom.	21	63	567	9.00	67.5	32
1½-in.	1½-in.	Tank	16	48	643	13.40	100.5	83
1½-in.	1½-in.	Tank	12	36	262	7.28	54.6	83
1½-in.	1½-in.	Flushom.	20	60	401	6.68	50.1	55
1½-in.	1½-in.	Tank	16	48	376	7.83	58.7	55
1½-in.	1½-in.	Tank	9	27	443	16.40	123.0	62
1½-in.	1½-in.	Tank	6	18	349	19.39	145.4	62
1½-in.	1½-in.	Tank	12	36	179	4.97	37.3	50
2-in.	2-in.	Tank	45	135	1331	9.86	74.0	91
2-in.	3-in.	Flushom.	58	174	1332	7.66	57.5	97
2-in.	2-in.	Flushom.	24	72	674	9.36	70.2	98
2-in.	2-in.	Flushom.	18	54	1012	18.74	140.6	100
2-in.	2-in.	Flushom.	43	129	1009	7.82	58.6	84
2-in.	2-in.	Flushom.	48	144	1289	8.95	67.1	84
2-in.	2-in.	Flushom.	24	72	566	7.86	58.9	84
2-in.	2-in.	Flushom.	20	60	432	7.20	54.0	91
2-in.	2-in.	Flcshom.	30	90	695	7.72	57.9	99
2-in.	2-in.	Flushom.	29	87	841	9.67	72.5	64
2-in.	2-in.	Tank	31	93	635	6.83	51.2	38
3-in.	3-in.	Flushom.	50	150	1485	9.90	74.2	64
3-in.	3-in.	Tank	86	258	1954	7.57	56.8	91
3-in.	3-in.	Flushom.	36	108	968	8.96	67.2	91
3-in.	3-in.	Flushom.	34	102	1017	9.97	74.9	98
3-in.	3-in.	Flushom.	41	123	702	5.71	42.8	98
3-in.	3-in.	Flushom.	93	279	1984	7.11	53.3	99
3-in.	3-in.	Flushom.	65	195	1346	6.90	51.7	101
3-in.	3-in.	Flushom.	38	114	600	5.26	39.4	99
3-in.	3-in.	Flushom.	73	219	1562	7.13	53.5	65
3-in.	3-in.	Flushom.	134	402	3813	9.49	71.2	59

*G. M. Stout, President of the Atlanta Real Estate Board; Wm. L. Hancock, President of the Apartment House Owners, and W. M. Rapp, Supt. of Construction and Distribution, Atlanta Water Works, were of the opinion that three occupants for each apartment would be a fair average during the entire year.

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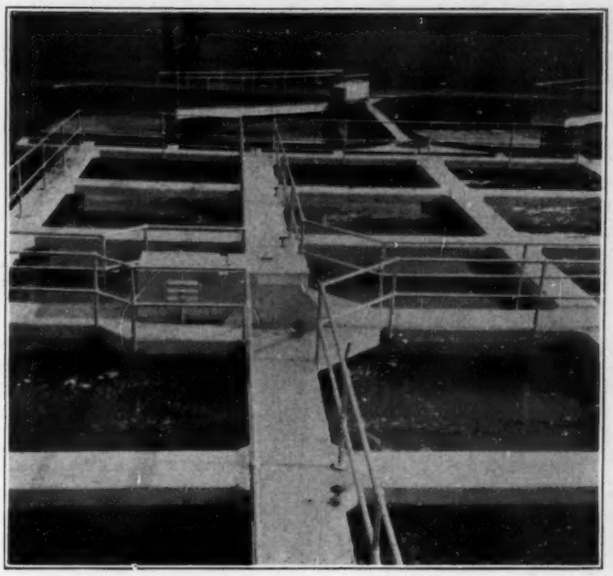
Utica, N. Y., to Have Sewage Treatment Plant

General project plans have recently been approved by the New York State Department of Health for sewage treatment works for the city of Utica, N. Y.

Salamanca, N. Y., and the towns of Glenville and Rockland, N. Y., will also construct sewers and treatment works which have been approved by the State Department. During July, 41 sets of plans for sewerage were submitted for the department's approval, many of which involved sewage treatment.

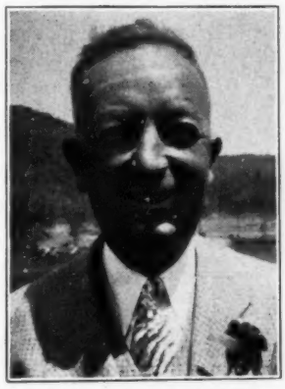


Aeration Tank, Newark, N. Y. Note Small Amount of Air Reaching Surface Submerged Paddle-Diffused Air Combination.

OPERATING EXPERIENCES AT NEWARK, N.Y. SEWAGE TREATMENT PLANT*

By THOMAS J. SMITH

Supt., Sewage Treatment Plant, Newark, N. Y.



Thos. J. Smith

THE Newark plant was designed to treat an average dry weather flow of 1.5 million gallons of domestic sewage per day from a separate system. It is of the activated sludge type, in which the raw sewage is settled ahead of aeration, and the combined raw and activated sludges are digested prior to dewatering on covered sludge beds. The various design features of this plant have been described in detail by Mr. Glenn D. Holmes, Consulting Engineer, in WATER WORKS AND SEWERAGE for May, 1933.

Plant Changes and Improvements

The plant was started up in October, 1932, and since then has been in continuous operation substantially as designed, except for a modification in the method of sludge digestion, which involved changing from single stage to two-stage digestion. Other major changes were as follows:

1. The bar screen was housed to reduce odors and improve the sightliness of the plant. The building was made large enough to hold the screenings storage cans and structurally harmonize with the other plant buildings.
2. The original 15 b.h.p. gas engine was replaced by a Clark 20-40 h.p. vertical engine. This change was made because the original engine, running continuously at rated load, would not stand up. To date, the new unit is giving very satisfactory service.
3. The activated sludge return pumps, which would not stand up, were changed to Rumsey Turret type pumps.
4. The heat exchanger, for utilization of waste heat in the gas engine exhaust, was replaced by a home-made unit. The original unit burned out due to the corrosive action of the hot gas which is abnormally high in hydrogen sulfide.
5. Plug valves in the sludge lines were replaced with new Chapman plug valves. The original valves lived up to their names too literally, and became plugged so tightly that it often took the combined effort of three men to turn them.
6. The small centrifugal sump pump in the pump and blower house clogged continually. This was removed and the Barnes sludge pump connected up to an automatic float switch and made to do the double duty of a sludge and sump pump.

Minor difficulties—perhaps minor to the engineer, but major tribulations in the daily life of a plant operator—caused us to:

1. Raise the air orifice meters above water level to prevent water from entering the manometer lines and giving false readings;
2. Install screen-type flame traps in the gas lines to reduce explosion hazards;
3. Remove a number of gadgets from the gas line running to the gas engine;
4. Connect a self-starter to the gas engine, etc.

Beside these changes considerable time has necessarily been spent in beautification of the plant grounds, painting buildings and equipment, and rearranging the laboratory, etc.

Operating Results

Since the plant was first put into operation, the daily average flow has varied from 0.37 to 2.1 m.g.d., the

*This article, prepared for WATER WORKS AND SEWERAGE, was also presented as a paper before the New York State Sewage Works Association at Poughkeepsie, N. Y.

The Sewage Treatment Plant of Newark, N. Y. The Converted Digester Appears in Center, with Second Stage Digester Hidden. Left Center Is Gas-Engine House.

average being 0.764 m.g.d. Screenings and grit removal have amounted to 1.98 cubic feet per m.g. and 3.23 cubic feet per m.g. respectively. Samples collected during the daytime showed suspended solids results as follows: raw sewage 332 p.p.m.; settled sewage 135 p.p.m., and final effluent 8.8 p.p.m. Corresponding 5 day B.O.D.'s averaged 360 p.p.m. for the raw sewage and 16.8 p.p.m. for the final effluent. These results are averages covering a period of 134 weeks.

Aeration Tanks

It is an interesting fact that the quality of the final effluent has improved during each succeeding year of operation, although the sewage flow and strength has increased. For example, the effluent ran 11.1 p.p.m. suspended solids during the first year, 8.3 p.p.m. during the second year and 4.1 p.p.m. to date during the third year. This fact might well be attributed to the increased experience of the plant operators, chiefly in regulating the mixed liquor solids in the aeration tanks. We find that we secure best results with mixed liquor solids averaging between 700 and 1,000 p.p.m.—by weight. At 700 p.p.m. the volume of sludge solids, after a 30 minute settling, amounts to 20 per cent, or thereabouts.

It is a well known fact that the rate of oxidation of sewage in the activated sludge process follows the laws of mass action. In the language of the plant operator this means the higher the solids in the aerator, the faster is the sewage purified. If this were the only factor involved, activated sludge plant operation would be simple. However, it has also been established that the higher the solids in the mixed liquor the slower is the settling rate in the clarifiers. Also, the amount of air required is *directly* dependent upon the mixed liquor solids and *not* primarily on the strength of the raw sewage. In addition, the return sludge solids must increase with increased strength of the raw sewage in order to obtain the same degree of purification in a given time. Taking all these factors into consideration, it is obvious that with a plant operating at rated capacity on an average strength sewage and with an aeration period of only 5 to 6 hours, it is necessry to carry relatively high solids in the aerators, i.e., about 3,000 p.p.m. In order to maintain aerobic conditions in this material would require at least 0.8 cubic feet of air per gallon of sewage using straight diffused air.

Now consider Newark conditions. Here the plant was designed to handle 1.5 million gallons of sewage per day. This flow, with 25 per cent return sludge, allows for an aeration period of 5 hours. But—and this "but" applies to nearly all new plants—our present flow is such that the average aeration period is 10 hours. As our conditions of flow are such that one aeration unit cannot be conveniently taken out of service, we have an extra 4 to 5 hours of aeration to "play with." This allows us to reduce the volume of sludge reurned, which in turn aids settling and reduces the quantity of air required. Unfortunately, we do not have sufficient flexibility in our blower installation to allow the reduction of air to minimum requirements. The lowest air quantity we can produce with our gas-engine-driven-blower is 300 cubic feet of free air per minute, which gives 0.565 cubic feet per gallon of sewage treated during the average 10 hour aeration period.

Our aerators are of the combined paddle and diffused air type. In one of the units the paddles are arranged to rotate against the air. This unit receives 100 cubic feet of air per minute, or 0.377 cubic feet per gallon of sewage. In the other tank the paddles rotate with the air current. Here the air quantity is varied from 200 to 340 cubic feet per minute, depending on the volume and strength of sewage being received. As far as we can tell from dissolved oxygen tests, the unit in which the paddles operate against the air gives at least as good results as the other, although the air required is considerably less.

We have had bulking sludge on several occasions. Each time this condition was directly traceable to an excessive solids content in the aerators and was readily corrected by wasting sludge until the mixed liquor solids fell below 2,500 p.p.m.

Sludge Digestion

Waste activated sludge is pumped continuously to the raw sewage. The mixed raw and activated sludges are pumped from the primary clarifier to the digester six times per day, twenty minutes for each period. Sludge pumpage to the digesters has varied from 1,500 to 6,000 gallons per day. At the present time the volume pumped is 5,400 gallons per day, amounting to 6,000 gallons per million gallons of sewage. On this basis, figuring that the average suspended solids removed amounts to 230 p.p.m. for a flow of 0.89 m.g.d., the dry solids content of the sludge averages 3.8 per cent. This sludge contains 82.5 per cent volatile matter. Under well controlled conditions the fresh sludge has run as high as 8.0 per cent solids.

There are two 30 ft. diameter sludge digestion tanks, one a plain converted old Imhoff tank, and the other a new tank equipped with a Dorr mechanism. These units were originally designed to operate in parallel. At the start of operation, and in cooperation with the Dorr Company, a Turbo-Mixer mechanism was installed in the plain tank and its depth was reduced to 15 feet by blocking off the lower portion with a wood floor. The units were then arranged to operate in series by a slight change in piping. Under this system of stage digestion all the fresh sludge is added to the Turbo tank, which operation forces an equal volume of partially digested bottom sludge through a syphon pipe to the secondary tank. The Turbo-Mixer mechanism mixes the contents of the primary tank with a swirling motion so that a uniform solid content is kept throughout the tank. This prevents the depletion of digested sludge in the first unit. Supernatant liquor is drawn from the secondary unit to the gas holder seal from where it returns to the raw sewage.

The Effect of Stage Digestion

Results covering a period of 247 days showed that under the method of operation described above, the average daily gas production was 7,240 cubic feet daily, 84.5 per cent being obtained in the first stage. Neglecting the initial starting period, when gas production was

higher than normal, the daily production was 6,100 cubic feet per day. The reduction in volatile matter was 42.6 per cent in the first stage and 55.5 per cent for both stages. The detention period in the first stage as determined by volumetric pumpage of fresh sludge was varied from 14 to 28 days. The digested sludge as drawn to the sludge beds contained about 5 per cent solids of which 33 per cent was ash. It might appear from this low ash content that this sludge was not well digested. However, considering the fact that the raw sludge ash was as low as 17.5 per cent, the change in ash is considerable and is equivalent to results obtained at a plant where the raw sludge contains 25 per cent ash and the digested sludge 43 per cent ash. The overflow liquor during this period contained only 0.27 per cent total solids. This material caused no difficulty when returned to the raw sewage.

At the expiration of the test period, the Turbo-Mixer was removed and the digesters put into normal parallel operation as originally designed. Then, during a 152 day period, the average gas production was only 4,060 cubic feet per day. During this period the overflow liquor total solids exceeded 2.0 per cent. This material, when returned to the sewage flow, caused septic action in the primary clarifier and in the aerators. It was then run to a sludge storage tank and from there to the sludge drying beds.

Due to the decreased gas production while single stage digestion was being practiced we were not able to run our gas engine continuously as had been done during the two-stage digestion period. Chiefly for this reason, a new Turbo-Mixer mechanism was purchased and permanently installed in the plain tank, and stage digestion resumed. Since this new unit has been in service, the gas has again averaged 6,230 cubic feet per day over a period of 211 days.

The average temperature in the digesters has been maintained at 80 deg. throughout the entire period of operation.

Gas Quality

Analyses of gas collected during the various periods of operation gave the following results:

	10/4/32[1]	11/15/32[1]	5/2/33[2]	5/16/35[2]
Methane	47.2%	71.8%	67.2%	67.7%
Carbon dioxide and Hydrogen sulfide	45.8	20.1 2.6*	29.8	27.7
Nitrogen	5.88	0.7	0.8	4.1
Carbon monoxide	....	1.1	....	0.0
Oxygen	0.9	0.4	0.2	0.2
Hydrogen	....	3.1	1.6	0.0
Illuminants	0.4	0.2	....	0.3

The first analysis was made right after the digesters were put into operation and show the high carbon dioxide characteristic of this period.

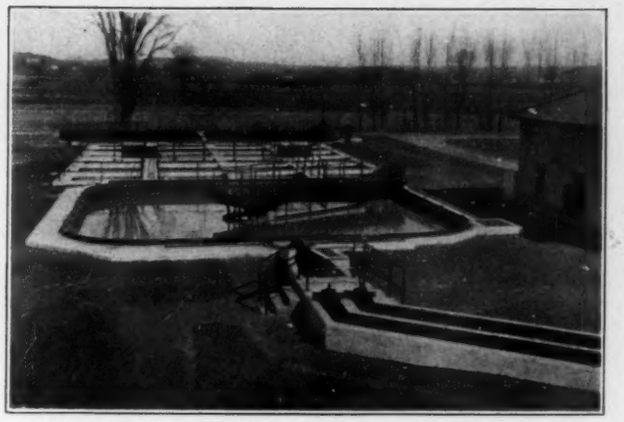
Numerous tests for hydrogen sulfide were made by various methods. The most reliable tests, made with a Bunte apparatus, gave results varying from 0.5 to 4.6 per cent. To date no attempts have been made to scrub the gas for removal of the hydrogen sulfide. We find that if temperatures are kept high enough in the gas engine, hot water heater, etc., it does not cause any serious trouble in these units.

Miscellaneous Experiments

We have adopted a policy of welcoming experimenters at our plant as we feel that we are definitely interested in any new device or process that will improve our results or lower our operating costs. It is always understood, of course, that such experiments entail no expense on the part of the village and that they do not harm our effluent. Time does not permit a full discussion of all the tests run up to the present time. Besides those on digestion, the most important ones completed or under way, are:

1. Superchlorination of sludge in cooperation with the Diamond Akali Co. Here the fresh sludge was chlorinated to the point where it became completely stabilized. The chlorinated sludge was dewatered both on sand beds and on vacuum filters.
2. Chlorination of fresh sludge to promote thickening ahead of digestion. In this test, sludge was drawn by gravity to the scum well where approximately 10 lbs. of chlorine were added per 1,000 gallons of sludge containing 6 per cent solids. Any scum that formed was circulated back to the raw sewage by an air lift. The limited capacity of the scum well prevented the carrying out of this idea to best advantage. With an adequate thickener capacity we feel that the system has definite advantages. A chlorinater was loaned us for this work by Wallace and Tiernan. The Mathieson Alkali Co. furnished the chlorine.
3. In cooperation with the Industrial Chemical Sales Co. activated carbon has been applied to the raw sewage since last February. The rate of dosing has been 35 lbs. a day, the material being fed by means of an ordinary hose from a barrel. Although results are as yet inconclusive we believe that this carbon addition has reduced hydrogen sulfide odors in the raw sewage and has also reduced the scum formation in the primary clarifier by about 75 per cent. Gas production in the digesters does not appear to have been affected nor has any change been noticed in the quality of the final effluent. It is interesting to note that, although the carbon used was very finely divided, none appeared in the final effluent.

In addition to these tests, laboratory and plant studies have been made on bio-flocculation and chemical treatment of raw and settled sewage, addition of ferric chloride to assist activation and addition of yeast to promote digestion.



Primary Clarifier, Paddle-Diffused Air Aerators and Final Clarifiers Beyond. Engine House on Right.

Costs

The total installed cost of the Newark plant was $116,978, or $78,000 per m.g.d. Fixed charges for 1933 and 1934 have been as follows:

	1933	1934
Insurance	$ 127.35	$ 125.32
Bond	5,000.00	5,000.00

*Hydrogen Sulphide.
[1]Analyses by Syracuse Lighting Co.
[2]Analyses by Geneva Gas and Electric Co.

Bond Interest	4,750.00	4,500.00
Retirement	180.00	180.00
	$10,057.35	$9,805.32
Per cent of original investment	8.60	8.38
Total per m. gals. sewage actually treated	$39.00	$36.00
Total per m. gals. based on design capacity of 1.5 m.g.d.	18.35	17.90

The plant personnel consists of two day operators, who also take care of three pumping stations in various parts of the village. No one is in attendance at night. Additional help is supplied occasionally for removal of grit and screenings and for repair work. During the first nine months of operation in 1933 the consulting engineer was retained to advise on initial operation. Part of the time of the superintendent of the Village Municipal Board is charged against the disposal plant as is also the time of a consulting electrical engineer.

Operating costs for 1933 and 1934 were as follows:

	1933	1934
Salaries, including supervision	$4,355.82	$4,053.74
Power and light	1,987.30	2,087.14
Supplies—coal, oil, grease, tools	285.97	304.31
Repairs, including pump station repairs	300.44	1,223.30
New equipment	693.03	2,188.00
Misc. shrubs, laboratory equipment, etc.	65.25	23.39
	$7,687.81	$9,879.88
Cost per m. gals. sewage actually treated	$29.70	$35.20
Cost per m. gals. based on design flow of 1.5 m.g.d.	14.00	18.00

Under new equipment for 1933 are included the new screen house, a lawn mower and an air compressor to start the gas engine. In 1934, new equipment included the Clark gas engine and the Turbo-Mixer.

Under repairs for 1934 are included the cost of installing the gas engine, remodelling the plain digester, and installing a new heat exchanger.

Omitting the new equipment and changes in the digesters, average operating costs covering the two year period were $7,043 per year, or $26.50 per million gallons of sewage treated. As there would be no extra charges if the plant were operating at full capacity (handling the design flow of 1.5 m.g.d.) the operating cost would be $12.85 per m.g., exclusive of fixed charges, and $30.75, including fixed charges.

In 1934 the village signed a contract with a local nursery for the sale of all the digested sludge produced at the plant during the next three years. The contract price was $5.00 per ton of dry sludge on the beds. We estimate that this will bring in a revenue of $1,000 per year, besides saving the village $400 per year on sludge removal from the beds. This will reduce our overall operating costs considerably during the next few years.

Acknowledgment.—The writer wishes to acknowledge the helpful cooperation of the Newark Municipal Board in the operation of the plant. The advice and assistance of Holmes and O'Brien, Consulting Engineers, and the Dorr Company, Inc., are also greatly appreciated.

The sewage treatment plant is under the general supervision of Mr. L. H. Wright, Superintendent of the Newark Municipal Board, and is in direct charge of the writer. Mr. W. Verdou is assistant operator.

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Stream Pollution Study Financed by PWA Grant

An allotment of $20,000 from old public works funds to the Bureau of Fisheries, Department of Commerce, for an experimental survey of the effects of pulp mill and other pollution on oysters in the York River, Virginia, was announced recently by Public Works Administrator Harold L. Ickes.

The survey comes in response to complaints that the oyster and shell-fish business in the York River, upon which 10,000 persons are dependent, has diminished nearly 50 per cent in the last ten years as a result of pollution from factory waste.

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Hazard of Inflammable Wastes Discharged Into Sewer Systems

A fire in the municipal sewage treatment plant in Middletown, N. Y., believed to have been caused by the ignition of gasoline wastes, is reported in Health News. The damage was confined principally to the interior of one building. A fire of similar origin took place at the plant shortly after it was put into operation in 1930.

The sewage treatment works, constructed at a cost of about $200,000, consist of coarse bar screens (2½-in. openings), grit chamber and bar screens (1-in. openings), chlorination equipment, settling tanks, separate sludge digestion tanks and sludge drying beds.

The operator first noticed the fire in the coarse bar screen chamber as the sewage entered the plant. The flames followed the sewage into the building, appearing first in the grit chamber and then at the screen chamber. The fire was extinguished in about an hour with Foamite by the city fire department. In the meantime, the sewage was bypassed around the plant.

Fortunately there was no serious damage to the equipment. The paint on the interior of the building was badly scorched, however, and window panes were broken.

This experience, which might have ended disastrously, emphasizes the importance of preventing the discharge of inflammable wastes into sewer systems and the desirability of the adoption and enforcement of suitable local ordinances to regulate such conditions.

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Leakage Survey Profitable Work Relief Project

In 1932 about half of the water supply of Lancaster, N. Y., could be accounted for by meter records and was apparently lost in leakage.

As a work relief project the municipality conducted a thorough leakage survey which revealed needed repairs and corrections since made. Now, according to the report of its Department of Public Works, Lancaster can account for all but 19 per cent of the water entering its distribution system. The per capita consumption in 1934 was 53 gals. per day, whereas in 1932 the water lost or unaccounted for amounted to 33 per cent of that paid for—viz.: 18 gals. per capita per day.

The leakage survey has proved a worth while work relief project at Lancaster, reducing unaccounted for water from 42 per cent to 19 per cent.

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Los Angeles City Departments Pay for Water

The Los Angeles Board of Water Power Commissioners has authorized the transfer of $150,000 of power revenue funds and $150,000 of water revenue funds to the city general fund. The money will be used to pay for electric and water services furnished various city departments by the Department of Water and Power. The Department's action represents a $300,000 savings to Los Angeles taxpayers.

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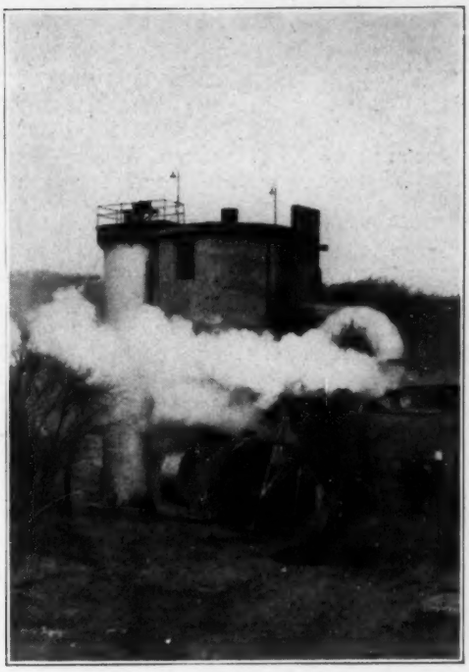
11 Cities Adopt Council-Manager Plan.—Since Jan. 1, 1935, eleven cities have adopted the council-manager plan of city government. In addition three cities and two counties have set dates to vote on adopting the plan. The two counties are Lucas and Hamilton in Ohio.



View of Plainfield Sludge Drier in Operation, Showing Cloud of Exhaust Steam.

SPRAY DRYING OF SLUDGE

By JOHN R. DOWNES

Superintendent, Joint Sewage Treatment Works of Plainfield, N. J.

The Author

THE spray drying of food and commercial products has been in practical use for some years. The possibilities of this method of drying sewage sludge come to the mind of the writer about 6 years ago when listening to a lecture by Mr. C. L. Riley of Industrial Associates. Approached about the matter, Industrial Associates were not keenly interested in trying to dry a more or less valueless product at that time. However, as new developments and economies had changed the picture considerably by 1933 the process as applied to sludge began to appear practical, and a full size plant unit was installed at the Plainfield, North Plainfield and Dunellen Joint Sewage Works in that year. The drying unit is now in regular use drying all the digested sludge from the sewage contributed by 50,000 persons. It is operated 9 hrs. per day on 6 days of the week.

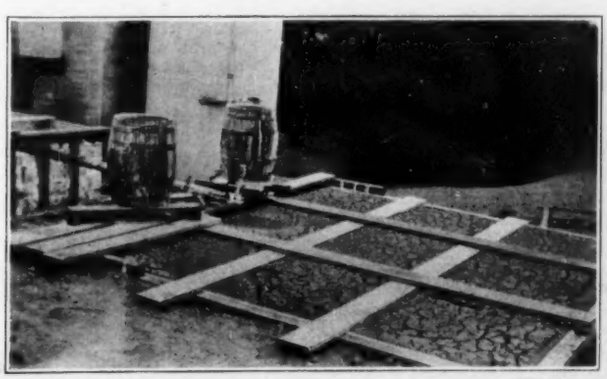
Principle of Process

The process is based on the rapidity with which water evaporates when exposed in the form of a mist to heated air, and the even greater rapidity of evaporation when the pressure is slightly below atmospheric. Obviously the applicability of this method to sludge drying centers about a practical method of atomizing the sludge into the form of a mist and the economics of the process.

The sludge is very successfully atomized by the combined centrifugal and chopping effect of a cage type spraying bowl, 6 inches in diameter, revolving at 9,600 r.p.m. Strange as it may seem, when we consider that the openings in this cage-like bowl are on the order of 1 inch deep and 1¼ inches long, there has never been the slightest tendency to clog or become fouled, although the sludge is being put through the cage at the rate of 70 lbs. of sludge (10 per cent solids) per minute.

The atomizer delivers the mist to the top of the drying chamber, a carefully insulated octoganal chamber, 20 ft. in diameter and 20 ft. high. The heated air and combustion gases from the furnace are drawn through the drying chamber. These enter annularly at the top and are drawn off at quarter points at the bottom. The balance between the volume of air, size of inlet ports, and fire-bed resistance is such that a negative pressure in the drying chamber (2 inches of water) exists. The volume of air circulated in the system is on the order of 10,000 times the volume of sludge to be dried. The air is recirculated in an almost closed system to gain thermal economy. A small amount of fresh air, in addition to that used for combustion, is admitted to make up for the air discharged with the escaping vapor.

Heat is supplied by the combustion of soft coal fed to a brick lined furnace by means of an underfeed stoker. The air is heated to about 700 deg. F. at the entrance to the drying chamber and is held uniformly at this temperature by means of the thermostatically controlled stoker. It escapes one-half minute later at a temperature of about 220 deg. F., having, meanwhile, given up its heat in the useful work of evaporating the moisture from the atomized sludge. The exact tempera-



Supernatant Liquid from Digesters Being Thickened by Flotation. Photo Taken 5 Hours After Addition of Alum.

ture of the exit gas is likewise maintained by thermostatic control of the supply of sludge to the atomizer. The exit temperature determines the dryness of the product and may be varied over a considerable range.

For a more detailed description of the plant see the 1934 Proceedings of N. J. Sewage Works Association, or WATER WORKS AND SEWERAGE for June, 1934 (p. 220).

Results of Operation

Naturally, with the application of an entirely new principle and method, many unforeseen difficulties had to be overcome. Now, however, the plant has been in operation for about a year, and during the past nine months it has dried practically all of our sludge. During the past two months it has been in daily operation with no shutdown or interruptions for adjustments or repairs.

Being a regenerative, closed circulation, heat transfer system, the first requirement was to secure the proper balance of heat, air circulation and sludge supply. The second requirement was to secure the best design of atomizer bowl for sludge conditions. This problem divided itself into two parts; design for best atomization, and bowl construction to withstand the abrasive action of the sludge at the high speed of rotation required. A third problem was the cooling and lubrication of the lower part of the atomizer unit operating at 9,600 r.p.m. in a temperature of about 700 deg. F. A fourth problem was to secure the coal best suited to the stoker and local conditions.

The most troublesome condition with which we had to contend was the specification of asbestos covered wire in the tower walls to meet possible heat conditions which, due to the excellent insulation, did not materialize. Substitution of fireproof rubber covered wire for the asbestos covered wire has ended a long period of grief due to short circuiting.

Costs of Operation

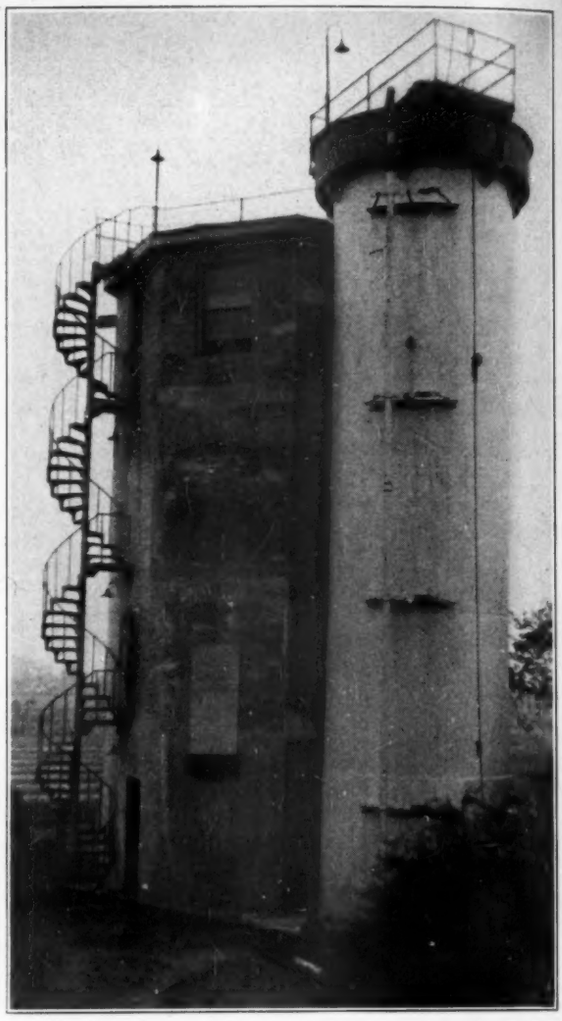
Now that the feasibility of the general scheme seems proven, beyond a doubt, the thought uppermost in the mind of the reader will be that concerning the costs of operation. That is a question not easily answered in dollars and cents in a way that would be useful in other locations than that of our plant.

Let us start with the conservative statement, that by this method we can consistently evaporate 8 lbs. of water for each pound of coal burned. This statement is based on a large number of short runs (six to nine hours), because for these periods of time we can accurately measure the sludge by the actual drop in depth in an elevated storage tank. Beyond this length of time there is no accurate means of measuring the sludge. It seems probable that for longer runs this evaporation factor might be somewhat higher.

The table below shows the weight of water to be evaporated from sludge containing one ton of *dry solids* at various sludge densities, to secure a product of various densities:

ONE TON OF DRY SOLIDS

Sludge Containing	Total Weight of Water	Water to Evaporate to Secure Product of 60% Solids	70% Solids	80% Solids	90% Solids
5% Solids....	38,000	36,670	37,143	37,500	37,778
10% Solids....	18,000	16,670	17,143	17,500	17,778
12% Solids....	14,666	13,336	13,809	14,166	14,444
15% Solids....	11,333	10,003	10,476	10,833	11,111
20% Solids....	8,000	6,670	7,143	7,500	7,778



The Plainfield Sludge Drier, Sludge Tank on Right; Atomizer Chamber (Concrete) on Left. Stoker Room Door in Foreground.

Note.—Product containing 60 per cent solids is nice to handle for immediate local use, but cannot be stored successfully.

Product containing 70 per cent solids is easily handled and stored.

Product containing more than 70 per cent solids is rather dusty to handle and would be avoided in ordinary operation except to meet definite market requirements.

A glance at the above table will indicate the folly of attempting to dry sludge containing only 5 per cent solids. On the other hand, with present equipment, sludge containing more than 12 per cent solids can be pumped only with the greatest difficulty. We shall, then, select a sludge with 10 per cent solids as that practical for a cost calculation. As you will note from the table, the degree of dryness to which the product is taken is a comparatively insignificant consideration from the evaporation angle.

If we undertake to reduce sludge of 10 per cent solids to a product of 70 per cent solids, we have (from the table) 17,143 pounds of water to evaporate, or a coal requirement of $\frac{17{,}143}{8} = 2{,}143$ pounds.

Now, since the stoker capacity is 500 lbs. per hour of coal,* it will require $\frac{2{,}143}{500} = 4.3$ hours to evaporate this weight of water. And, since the power required

for total operation of the drier unit is 22 kw. per hour we have 4.3 × 22 or 94.6 k.w.h. For convenience, say 95 k.w.h.

Labor cost, like power, is dependent on the time required for drying and 4 lbs. of alum is used per ton of 5 per cent digested sludge in order to concentrate this sludge to 10 per cent solids content by flotation—*not precipitation.*

So, we require for drying one ton of dry solids:

Coal	2,084 pounds
Power	95 k.w.h.
Labor	4.3 hours
Alum	80 pounds

These are basic figures for operating costs. The reader should insert his own local unit costs. Under Plainfield conditions they total $12.04 as the cost of production of one ton of solids (dry basis) when received in the form of digested sludge with 5 per cent solids content which is then concentrated to 10 per cent solid sludge by alum flotation, and then dried to a 70 per cent solids product by means of the heat drier.

Given sufficient time, the same amount of alum will reduce the moisture in the initial digested sludge from 95 per cent to 88 per cent, giving a sludge of 12 per cent solids content for feeding to the drier. Under these preferred conditions the requirement will be:

$$\frac{13{,}809}{8} \text{ or } 1{,}728 \text{ lbs. of coal.}$$

$$\frac{1{,}728}{500} \text{ or } 3.5 \text{ hours operation.}$$

Coal	1,728 pounds
Power	76 kw.
Labor	3.5 hours
Alum	80 pounds

For Plainfield conditions this procedure results in a cost of $9.86 per ton of dry solids turned out.

For sludges more concentrated than 12 per cent solids a whole new set of conditions would be set up; because, power for atomizing, pumping, etc., mounts rapidly beyond this point. It has been demonstrated that sludge of 30 per cent solids can be atomized by such a spray unit as is used at Plainfield, but we have had no opportunity to analyze costs of drying sludge in which the initial solids content is greater than 12 per cent.

Disposal of Product

The dried product, which contains about 30 per cent moisture, looks like good wood loam and immediately appeals to the heart of any garden enthusiast. It has been described as "The sludge you love to touch." It makes a particularly fine showing on lawns, and we have had excellent reports from its use on gardens. Now the greenhouse men are taking it up and it is reported equal to any other fertilizer for geraniums and the best of all for gardenias.

We have no trouble in getting $10.00 per ton for the sludge "as is." This price for 30 per cent moisture sludge is equivalent to $12.04 per ton of dry solids as compared with the drying cost of $12.12 for drying 10 per cent solids sludge or $9.86 for drying 12 per cent sludge. This differential will, we believe, give us sufficient to take care of maintenance and repairs which were not included in the drying costs for the simple reason that we have, as yet, no data on which to base an estimate.

*In the original articles referred to, the stoker rate was 400 lbs. per hour but it has since been stepped up to 500 lbs. per hour.—J. R. D.

The product can be very successfully burned in suspension by being blown back over the fire. It burns instantly with terrific heat and does not give off any odor when so burned. If all of the product is burned it supplies 33 per cent of the total heat required under present operating conditions. If the plan for drying denser sludges, now under consideration, can be worked out the product will supply practically the entire heat required.

Disposal of Supernatant Liquid from Digestors

By the combined chemical flotation and heat drying system the problem of disposing of the supernatant liquid from digestors is readily solved. The liquid either alone or preferably in combination with the heavy bottom sludge is easily amenable to the flotation treatment. The liquid is readily concentrated to the same density as the sludge. Heat drying from this point on is identical for sludge and liquid.

Odors

Digested sludge does not give off offensive odors in the drying process. Many persons note no odors in the exhaust steam; some detect a slight odor variously classed as sulphurous, musty and, in one case, ammoniacal. Since all of the combustion gases from the furnace pass off with the vapor it would not be surprising if there were sulphur odors. One critic was much disturbed because he could not determine whether the odor originated from the coal or the sewage.

Raw sludge cannot be successfully dried without odor under present conditions.

Asknowledgment is made to Mr. Ray Komline, Drier Attendant for assistance and criticism, and also for photographs accompanying this article.

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Carpenter Comes to New York University

Lewis V. Carpenter

Morgantown's loss is New York's gain!

Lewis V. Carpenter, Professor of Sanitary Engineering, at the University of West Virginia, has recently tendered his resignation and has accepted an offer from New York University to become a member of its engineering school faculty as Associate Professor of Sanitary Engineering.

Professor Carpenter became recognized for the thorough and interesting courses given at the University of West Virginia and especially the type of training given practical water works operators in preparing them for examinations under the West Virginia Water Works Operators' Licensing Act.

Mr. Carpenter became a leader in the West Virginia Water Works Operators Conferences and the Central States Section of A. W. W. A. He is a member of the Board of Directors of A. W. W. A. and Chairman of its Committee on Licensing Water Works Operators and Water Works Short Schools.

He comes to New York University with the beginning of its Fall term and will take over some of the work of Professor Thorndike Saville, who will devote more of his attention to his office as Associate Dean of the School of Engineering and his work with the Government on Water Resources matters.

A STUDY OF FILTERING MATERIALS FOR RAPID SAND FILTERS

Part 6: Mud Ball Formation and Measurement—Miscellaneous Items

By JOHN R. BAYLIS*
Associate Editor

THE effect of the kind of filtering material upon mud ball formation, measurement of the volume of mud balls in filters, use of coarse material of low specific gravity on top of fine material of higher specific gravity, and several miscellaneous items will be discussed in this article. The next and final article of the series will give suggested specifications for filtering materials.

In the course of the experiments on various kinds of filtering materials, observations were made on the effect of the kind of material upon mud ball formation. Attempts to compare the data indicated the need of a procedure for measuring the volume of mud balls to determine its proportion to the total volume of the filtering material. Such a procedure is offered. A more extensive discussion of mud balls is given in Part 4 (WATER WORKS AND SEWERAGE, 82:20-25, January, 1935).

For certain waters where the filter runs are very short during periods when microorganisms are abundant, the output of the filters is lessened and the quality of the filtered water may be impaired by the short filter runs. Anything which may be done to increase the lengths of the filter runs is worthy of consideration. A few tests have been made to determine if it is possible to place a layer of coarse material on top of finer material of higher specific gravity so as to lengthen the filter runs. The top material, serving somewhat as a roughing filter, removes much of the coagulated matter, but dependence is placed on the finer material underneath for complete removal of the coagulated matter.

Brief discussions will be given of the amount of water required for the surface washing system, and the effect of the porosity of the filtering material upon the clogging rate.

Effect of Kind of Filtering Material Upon Mud Ball Formation

Material Used.—The characteristics of the various kinds of filtering materials used in the experiments are given in Table 18. The sand was obtained from Muscatine, Iowa, and is material used extensively in filters located within shipping distance of Muscatine. The crushed quartz was obtained from Copley, Ohio, and is used to a limited extent for filtering purposes. The Minchar used was made from a clay-like product containing a small amount of carbon, which is heated to a high temperature in closed retorts. The material was produced for removing tastes and odors in water, but in this case was used for a filtering material. The reason for including Minchar in the tests was because of its low specific gravity and irregular shape of granules. The magnetite was a mined product which was crushed and sieved to the desired sizes. The granules were hard, and there are indications that it would be durable if used for water filtration purposes.

The anthracite coal was crushed and sieved to the desired sizes, and was typical of material now being used for filtering purposes. The iron ore was obtained from a stone picked up along the roadside in northern Michigan. It disintegrated too rapidly to be considered satisfactory. The crushed glass was made by crushing pieces of broken water bottles and sieving to the desired sizes. This material contained many flat and sharp-pointed particles.

TABLE 18.—MATERIALS USED IN TESTS ON VARIOUS KINDS OF FILTERING MATERIALS

Material	Filter	Effective Size mm.	Specific Gravity	Porosity Per Cent
Muscatine sand	DX-2	.489	2.65	44.0
Crushed quartz ...	EX-3	.475	2.65	52.7
Minchar	FX-4	.519	1.87*	56.0*
Magnetite	GX-4	.472	5.00	52.0
Anthracite coal	HX-3	.450	1.60	50.8
Iron ore	D-7	.331	3.25	55.0
Crushed glass	Z-4	.432†	2.45	54.7

†The real effective size of the crushed glass probably was about 0.55 mm. dia. Flat and sharp pointed pieces washed to the surface.

*Specific gravity and porosity could not be determined accurately.

Filters.—The experiments were conducted in glass-tube units the same as are illustrated in Part 2 (WATER WORKS AND SEWERAGE, 81; 162-168, May, 1934). The beds were 24 inches in depth, and the total volume of material in each filter was about one liter. The rate of filtration for all of the filters was kept at 2 gallons per square foot per minute. Two methods of washing were used. Part of the time the surface washes were used in addition to the wash water applied underneath the beds, and at other times all of the wash water was applied underneath the beds. The filters were washed at a rate which expanded the beds approximately 50 per cent each time they were washed. The procedure was to operate the filters without the use of the surface washes for some certain period of time, then use the surface washes each time the filters were washed for some definite period. The washing procedure was alternated several times within the period of a year. During the periods when the surface washes were used, all of the beds were kept in perfect condition and entirely free from mud balls without extra aid in breaking up the mud balls. This was not the case when all of the wash water was applied underneath the beds in the usual manner of washing, as will be shown.

Condition of Filter Beds When Surface Washes Were Not Used

Following a period of using the surface washes, and in which all of the filters were maintained in perfect

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condition, the surface washes were cut off and the beds washed at a rate to give 50 per cent expansion of the beds. The filters were washed until the wash water was clear and it was evident that additional washing would not remove more of the mud. The washing time was fully as long as it would have been on large filter units of the same materials. The time, of course, varied considerably for the different materials. The washing period for anthracite coal and Minchar usually was five minutes or longer, whereas two minutes or less were required for washing the magnetite because of the high rate required to produce 50 per cent expansion of the bed. The condition of the beds at intervals of one, two, and three months for a typical period in which the surface washes were not used is given.

MUSCATINE SAND (*Filter* DX-2)

One Month.—A large number of mud balls were present, ranging in size up to one-fourth inch in diameter. During washing, the mud balls extended from the surface of the expanded bed to within 3 inches of the bottom of the bed. There was no mud at the gravel surface. In cutting off the wash water slowly most of the mud balls congregated in the upper few inches of the bed.

Two Months.—Approximately 200 mud balls were present, ranging in size up to three-fourths inch in diameter. During washing, the mud balls extended from the surface of the expanded bed to within 2 or 3 inches of the gravel. The largest number remained in the upper half of the expanded bed, but very few were at the surface. No mud was observed at the gravel surface. Cutting off the wash water slowly, most of the mud balls congregated near the surfce.

Three Months.—There were about 150 mud balls present, ranging in size up to one-half inch in diameter. During washing, the mud balls extended from the surface of the expanded bed to within 6 inches of the gravel, with the largest number in the upper part of the bed. No mud was observed at the gravel surface. In cutting off the wash water slowly most of the mud balls congregated in the upper 8 inches of the bed.

CRUSHED QUARTZ (Filter EX-3)

One Month.—A number of mud balls were present, ranging in size up to three-fourth inch in diameter. During washing, the mud balls were distributed from the top of the expanded bed to the gravel surface. There was a slight accumulation of mud at the gravel surface. In cutting off the wash water slowly most of the mud balls congregated in the upper 3 inches of the bed.

Two Months.—There were approximately 125 mud balls present, ranging in size up to three-fourth inch in diameter. The mud at the gravel surface was about 1.5 inches thick. Other conditions were about the same as at the end of one month.

Three Months.—There were about 150 mud balls present, with the largest ones being about three-fourth inch in diameter. The average size of the mud balls were larger than for the Muscatine sand. The mud balls extended from the sand surface to the gravel during washing. There was about 2 inches of mud at the gravel surface. The mud balls tended to clump together near the surface of the bed when the wash water was cut off slowly.

MINCHAR (Filter FX-4)

One Month.—A number of mud balls were present, ranging in size up to three-fourth inch in diameter. During washing, the mud balls extended from the surface of the expanded bed to the bottom of the bed. There was about 4 inches of mud at the gravel surface. The mud balls remained fairly uniformly distributed throughout the material, even though the wash water was cut off slowly.

Two Months.—There were approximately 250 mud balls present, with the larger ones being about one inch in diameter. Other conditions were about the same as at the end of one month.

Three Months.—Conditions were unchanged at the end of three months, except the thickness of the mud at the gravel layer was only about 1.5 inches thick. Part of this mud had been broken up by turning the wash water on at a high rate for a few seconds during washing.

MAGNETITE (Filter GX-4)

One Month.—Very few mud balls were present, and the largest ones were only about one-eighth inch in diameter. The mud balls remained in the top 4 inches of the expanded bed during washing. There was no mud at the bottom of the bed.

Two Months.—There were approximately 100 mud balls present, with the largest ones being about one-fourth inch in diameter. During washing, the mud balls remained in the top 6 inches of the expanded bed. There was no mud at the bottom of the bed. In cutting off the wash water slowly the mud balls congregated in the top 2 inches of the bed.

Three Months.—Conditions were the same as at the end of two months.

ANTHRACITE COAL (Filter HX-3)

One Month.—There were a large number of mud balls present, with the largest ones being about one inch in diameter. During washing, the mud balls extended from the top of the expanded bed to the bottom of the bed. There was about 4 inches of mud at the gravel surface.

Two Months.—There were about 250 mud balls present, ranging in size up to one inch in diameter. During washing, the mud balls extended from the top to the bottom of the expanded bed, and remained fairly uniformly distributed throughout the bed both during washing and after the wash water was cut off. The mud at the gravel surface was about 4 inches thick. One noticeable difference between the anthracite coal and sand was that none of the mud balls showed at the surface of the coal after the wash water was cut off. The bed had the appearance of being very clean, but there was a great accumulation of mud within the bed and at the gravel surface.

Three Months.—There were about 150 mud balls present, ranging in size up to 1.5 inches in diameter. Frequently the clogging at the surface did not break up when the filter was washed, but gradually sank to the lower part of the bed. The mud balls remained fairly evenly distributed throughout the bed, and the mud at the gravel surface was about 4 inches thick.

IRON ORE (Filter D-7)

One Month.—There were numerous mud balls present, ranging in size up to one-eighth inch in diameter. During washing, the mud balls extended from the top of the expanded bed to about one-half the depth of the bed. There was no mud at the gravel surface.

Two Months.—There were approximately 150 mud balls present, with a few about three-fourth inch in diameter. Most of them were small. During washing, the mud balls extended from the top of the bed to about one-half the depth of the bed. There was no mud at the gravel surface.

Three Months.—Conditions were the same as at the end of two months, except the largest mud balls were about one-fourth inch in diameter.

CRUSHED GLASS (Filter Z-4)

One Month.—A number of mud balls were present,

ranging in size up to one inch in diameter. During washing, the mud balls extended from the top of the expanded bed to the bottom. There was a slight amount of mud at the gravel surface.

Two Months.—There were approximately 100 mud balls present, ranging in size up to about one inch in diameter. The mud balls during washing extended from the surface of the expanded to about 12 inches below the surface. There was no mud at the gravel surface. In cutting off the wash water slowly the mud balls congregated in the top 2 inches of the bed. Some of them showed at the surface.

Three Months.—There were about 150 mud balls present, ranging in size up to three-fourth inch in diameter. They remained mostly on the top 6 inches of the expanded bed during washing, but a few of them extended downward about 18 inches. They congregated in the top 3 inches of the bed when the wash water was cut off. There was no mud at the bottom of the bed. There seemed to be a greater tendency for the mud balls to clump together than was the case for most of the other materials.

High Specific Gravity Materials Are Best.—These tests indicate that filters having materials of high specific gravity would be troubled less with mud balls and clogging than filters of low specific gravity materials.

Measuring the Volume of Mud Balls in Filters

So little attention has been given mud ball formation in filter beds that no one heretofore has suggested a method of measuring the volume of the mud balls. If efforts are to be made to prevent their formation there should be some procedure to be followed in testing the volume so that the effectiveness of the extra washing, or agitation of the sand during washing, may be determined. There is question whether the samples of sand should be representative of the entire bed or some part of the bed where the mud balls usually are more numerous such as the top few inches. It is believed that measurement of the volume in the top 6 inches will give very good information on the condition of the sand. Also collecting samples from the top 6 inches of the filter is easier than collecting a representative sample of the entire bed. For certain materials, such as anthracite coal, the most desirable point to collect the sample may be just above the gravel. There, of course, may be many instances where it is desirable to collect a representative sample of the entire bed.

Procedure.—Wash the filter in the usual manner, then drain the water from it. Collect a definite volume of sand from the top 6 inches of the bed (or from other portions of the bed if desired). A 6-inch cube is sufficient in most instances, though a greater volume may be collected if great accuracy is desired. Collect from at least 4 parts of the bed. The sand sampler shown in Figure 2, Part 2 (WATER WORKS AND SEWERAGE, 81:164, May, 1934), is satisfactory. It may be better to make the sand sampler 3.38 inches diameter instead of 3 inches so that the area of a section across the cylinder is 9 square inches. Then filling the sampler 4 times will give a volume of 216 cubic inches, or one-eighth cubic foot. Place the sand on a 10-mesh standard sieve. Lower the sieve into water and with gentle up and down motions wash the sand through the sieve, taking care not to break up the softer mud balls. The sampler full of sand (42.42 cu. in. if the sampler is 3 inches in dia., or 54.0 cu. in. if it is 3.38 inches diameter) is all that should be placed on the sieve at one time.

The mud balls retained on the sieve are then transferred to a cylinder graduate partially filled with water. The size cylinder graduate to use will depend on the volume of the mud balls to be measured. Fill the cylinder graduate with water to some exact depth, such as one-half its capacity. Place the mud balls into the cylinder and read the increase in the volume of water. The volume should be computed in percentage of the volume of sand.

Volume of Mud Balls in Filters.—To obtain information on the rate at which mud balls increased in the filters of the Chicago Experimental Filtration Plant, three of the filters which had been kept free from mud balls by use of the surface washing system were used. Use of the surface washes were discontinued on these filters. The filters then were washed by applying all of the wash water underneath the beds. The rate of washing was approximately 15 gallons per square foot per minute, which produced about 35 per cent expansion of the beds.

Coagulated water without sedimentation was filtered through Filter 10; water after settling about 3.0 hours was filtered through Filter 7, and water settled about 6.5 hours was filtered through Filter 6. Samples of sand were collected weekly from the top 6 inches of the beds, and the volume measured. The filters were washed in the manner stated just before collecting the samples. Table 19 gives the results of the tests. The filters were operated at a rate of approximately 2 gallons per square foot per minute, and were washed each time the loss of head reached about 9 feet. The time of washing was 3 minutes.

TABLE 19.—MEASUREMENT OF VOLUME OF MUD BALLS IN TOP 6 INCHES OF SAND BEDS

	Filter No. 10	Filter No. 7	Filter No. 6
Hours settling before filtration	0.0	3.0	6.5
Date	Percentage Volume of Mud Balls		
April 25, 1935	0.00	0.00	0.00
May 2	2.60	0.00	0.00
May 9	3.79	0.28	0.17
May 17	4.23	0.34	0.23
May 23	5.65	0.90	0.17
May 31	8.47	1.86	0.40
June 6	9.35	1.84	1.08
June 13	11.9	2.97	1.07
June 20	11.6	....	1.47
June 27	8.75	2.77	2.03
July 5	13.0	3.95	2.26
Hours settling before filtration	0.0	1.8	3.8
July 11	12.4	3.66	3.38
July 19	15.5	5.65	3.11
July 24	13.0	5.92	2.82
Aug. 1	15.5	5.08	3.67
Aug. 8	12.7	6.49	3.39
Aug. 15	12.7	5.66	3.11
Aug. 22	15.5	5.64	2.82

The effect of settling upon the rate at which the volume of mud balls increased is interesting. The number of filter runs for the first 9 weeks were 163, 50, and 27 for Filters 10, 7, and 6 respectively. The accumulation of mud balls in the top six inches of sand was approximately .08 per cent of the volume of the sand for each run on Filter 10 up to a certain time, and approximately .07 per cent for each run on Filters 7 and 6. This indicates that the initial rate of increase in the volume of mud balls for the particular water varies nearly in the same ratio as the number of filter runs; that is, each filter run, when allowed to run to the same loss of head, produces about the same volume of mud balls regardless of the length of the run.

Experimental work on sedimentation of coagulated matter has shown for the Lake Michigan water that the length of filter run is approximately proportional to the amount of coagulated matter going to the filter for a given condition of water. This being the case, the

volume of mud balls formed for a given character of coagulated matter is approximately proportional to the amount of coagulated matter going to the filters. The same size of sand was used for all of the filters in the tests. It is likely that the size of the sand may have some influence on the rate of mud ball formation. There also is the possibility that the rate of washing has some influence on the number and volume of mud balls formed. These influences were obviated in the tests given by having the conditions the same for all the filters. The tendency to form mud balls, of course, varies greatly for different waters and different conditions of the same water. The effect of the kind of filtering material on mud ball formation has been given already. It was not possible to measure the volume of the mud balls in the glass tube filters without danger of breaking them up. The time selected for measuring the volume of the mud balls given in Table 19 was the time of year when the water was thought to have its greatest tendency to form mud balls. Change in the character of the water was at least partially responsible for the falling off in the rate of increase in the volume during the last few weeks of the tests.

The volume of mud balls cannot keep increasing indefinitely. This may be due to three causes. Some of the mud balls become so compact they settle to lower depths in the sand bed. The mud balls probably are gradually worn away each time the filter is washed, and a point may be reached where the rate of wearing away equals the rate of formation. A change in the character of the suspended matter may lessen the tendency to form mud balls. As stated, the latter is believed to be the main reason for the dropping off in the rate of increase in the volume of mud balls in the last few weeks of the tests given in Table 19.

Filter Beds Should Be Kept Clean

How clean should a filter bed be kept? This is a question in which there is difference of opinion. Years ago considerable attention was given to bacterial reduction through the filter beds. Now with the almost universal use of chlorine it is not so important that the filter beds produce some definite reduction of the bacteria. This is not intimating that a clean filter bed will give less bacterial reduction than one in which the sand grains are coated with a gelatinous film, though some believe the colloidal film is very desirable. The writer is of the opinion that the gelatinous film around the sand grains is of no material aid in the removal of coagulated matter from water. Certainly it is better to have no film, or a very thin one, than to have large numbers of mud balls in a filter. These mud balls frequently contain vast amounts of decomposing organic matter in the form of dead microscopical organisms and other organic matter. Where filters are not kept free from mud balls, much of this organic matter is retained in the filters for weeks, and it is evident that some decomposition takes place. There may be evidence that decomposing organic matter is not harmful, yet we prefer the amount in our drinking water as low as possible.

The person operating a filtration plant should strive to keep the mud balls less than 0.1 per cent of the volume of the sand or other filtering material. This applies to the top six inches, or to any other part of the bed. Where the percentage volume of mud balls exceed 0.2 per cent, extra facilities for washing the filter should be provided, such as the surface wash.

The following classification of filtering materials according to the percentage of the volume of mud balls in proportion to the total volume of the filtering material is suggested:

Per Cent Volume of Mud Balls	Condition of Filtering Material
0.0 to 0.1	Excellent
0.1 to 0.2	Very good
0.2 to 0.5	Good
0.5 to 1.0	Fair
1.0 to 2.5	Fairly bad
2.5 to 5.0	Bad
over 5.0	Very bad

Use of a Layer of Coarse Material on Top Of Fine Material of Greater Specific Gravity

In backwashing a filter containing material of the same specific gravity, the coarsest material settles to the bottom and the finer material goes to the top of the bed. There is not complete stratification according to size, yet nearly all of the fine material will be found in the top and nearly all of the coarse material in the bottom portions of the bed. If the particles vary in specific gravity, then the stratification is not altogether in accordance with the size. When there is considerable difference in the specific gravity of two materials the lighter material will stay at the top of the bed even though the particles may be considerably larger than the particles of higher specific gravity.

Ripple (*Water Works Engineering,* 88:277-279, March 20, 1935) has found by placing 6 inches of anthracite coal of larger particle size over filter sand that the lengths of the filter runs could be increased. We have conducted a few experiments similar to those of Ripple's, using thinner layers or coarse material. Most filtration plants handling lake water are troubled at times with short filter runs, and anything which may be done to lengthen the runs is worthy of consideration.

A two-inch layer of coarse anthracite coal was placed over a 22-inch bed of sand having an effective size of 0.495 mm. dia. in a glass tube filter, and a two-inch layer of coarse crushed quartz was placed over a bed of magnetite in another filter. The magnetite had a specific gravity of 5.0 and an effective size of 0.505 mm. dia. The coarse materials were retained on a 20-mesh sieve after passing through a 16-mesh sieve. The size ranged from about 1.00 mm. to 1.38 mm. dia. There was almost no mixing of the crushed quartz and magnetite, and while there was more mixing of the coal and sand it also remained fairly well stratified according to material.

Table 20 gives the results of tests covering a period of three months for the quartz and magnetite filter, and a period of two months for the coal and sand filter. The magnetite was somewhat larger in size than the sand in the sand filters used for comparison, but when both size and porosity are taken into consideration the runs on Filter N-4 were approximately three times longer than they were on the sand filters. This is approximately the same ratio for the coal and sand filter when compared with the sand filters.

TABLE 20.—EFFECT OF USING COARSE FILTERING MATERIAL ON TOP OF FINER MATERIAL

	Q-4	T-4	M-4	N-4
Effective size, mm.	.485	.502	.495*	.505*
50 per cent size of top material			1.18	1.18
Date	Hours Required for Loss of Head to Reach 8 Feet			
May, 1935	18.1	21.1		68.7
June	6.9	8.4	34.2	42.7
July	8.6	10.0	31.9	37.7

*Effective size of the fine material. Filter M-4 had a 2-inch layer of coarse anthracite coal overlying the sand, and Filter N-4 had a 2-inch layer of crushed quartz overlying the magnetite.

The short period of operation has produced a large accumulation of mud balls in the coal and sand filter

with most of the mud balls remaining within the coal at the top of the sand. A few mud balls were found in the quartz and magnetite bed. Most of these remained on top of the quartz, though several were noted at the top of the magnetite. The large accumulation of mud balls in the coal and sand filter would make the use of a surface washing system almost a necessity for the Lake Michigan water. There is doubt if the coal would long withstand the agitation produced by a surface washing system, though this has not been tried as yet. Three months operation of the quartz and magnetite filter did not indicate great need for a surface washing system, though it is believed such a system should be installed so as to keep the filter entirely free from mud balls.

Water Required for Surface Washing Filters

The surface washing system has been described already (WATER WORKS AND SEWERAGE, 82:20-25, January, 1935), but judging from questions which have been asked there is some misunderstanding about the amount of wash water required. The writer stated that it may be as low as 2 to 3 gallons per square foot per minute, or it may be as high as 7 to 8 gallons for unusual conditions. Many are of the impression that this amount of wash water is in addition to the amount being used already. If the present wash is entirely inadequate, the amount of water used may have to be increased. In most instances, however, the amount used need not be increased, but part of it will be passed through the surface washing system.

This statement may be made, which is applicable to all filtration plants: *With the use of a given amount of wash water, the filters can be kept in much better condition by passing some of the water through a surface washing system, than by passing all of it underneath the bed. To maintain filter beds in a given condition, the cheapest means of doing this is to use a surface washing system in combination with the regular washing system as has been recommended.* There may be places where more wash water will be required to keep the beds in perfect condition than is now being used to keep them in poor condition, but the improved condition should justify the use of the extra amount of wash water.

Effect of Porosity on Clogging Rate

In discussing the effect of the porosity of the filtering materials on clogging rate in Part 3 (October, 1934), it was stated that the lengths of filter runs varied approximately as the 2.13 power of the percentage porosity. This was based upon the lengths of the runs on filters washed at 50 per cent expansion of the beds without using the surface washes. The beds were not maintained in perfect condition by this method of washing. Tests in which the beds were maintained in excellent condition by use of the surface washes indicate that this figure is too low. The porosity effect for filter beds kept perfectly clean and free from mud balls is somewhere near the 3.0 power of the percentage porosity. It probably is slightly less than 3.0 when rounded and angular sands are compared.

Corrections

Page 166, May, 1934.

The equation for computing the effect of the size of sand upon the length of filter run is given

$$H = KD2.15$$

The equation should read

$$H = KD^{2.15}$$

Page 22, January, 1935.

Equation (6) should read

$$100\ S_1 = \frac{(S-1)\ (100-P)}{E} + 100$$

Summary

Observations have been made on the formation of mud balls in filter beds constructed of various kinds of filtering materials.

Applying all of the wash water underneath the beds at a rate to give 50 per cent expansion of the beds, mud balls formed in all of the filters, though to a lesser extent with materials of high specific gravity.

Mud balls accumulated at the gravel surface to the extent that they formed mud deposits in filters constructed of anthracite coal, Minchar, and crushed quartz.

The experiments indicate there will be less trouble from mud ball formation and clogged areas by using filtering material having a specific gravity greater than that of silica sand, and that there will be more trouble from such causes by use of material having lesser specific gravity.

A procedure for measuring the volume of mud balls in filtering materials is given, which consists of placing representative portions from the bed on a 10-mesh standard sieve. The sand is washed through and the volume of mud balls retained on the sieve measured.

Where there was about three hours settling of the coagulated water and starting with a clean bed, the volume of mud balls in the top 6 inches of sand increased to 5 per cent of the volume of sand.

For filters to be considered in excellent condition, the volume of mud balls in any part of the bed should be not greater than 0.1 per cent of the volume of sand, and when it is greater than 0.2 per cent of the volume extra washing facilities should be provided.

Use of a layer of coarse material over a bed of finer material of higher specific gravity is a practical means of lengthening the filter runs.

A surface washing system adequate to keep the filter beds in excellent condition will usually not require an increase in the total amount of wash water used.

Acknowledgement

The writer wishes to express his appreciation to the officials of the Department of Public Works, City of Chicago, for permission to publish the articles on filtering materials. Oscar E. Hewitt is Commissioner of Public Works; Loran D. Gayton, Acting City Engineer; and Arthur E. Gorman, Engineer of Water Purification.

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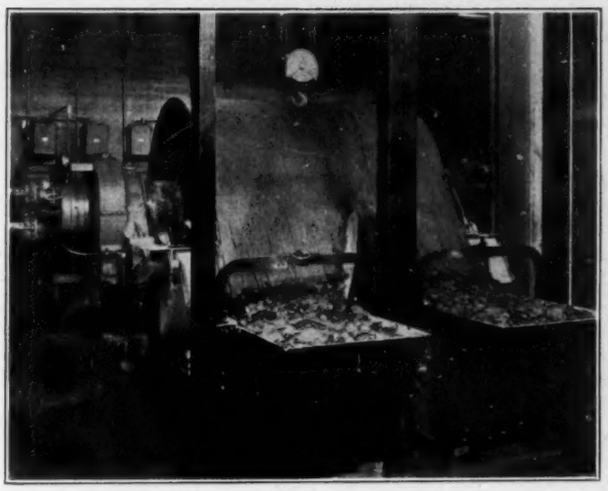
Investigation of Bell and Spigot Joints

Published as Engineering Experiment Station Bulletin No. 87 by Ohio State University, "Investigation of Bell and Spigot Joints in Cast Iron Water Pipes" is a booklet of 57 pages. The author, Professor John C. Prior of Ohio State University, is chairman of A. W. W. A.'s sub-commitee (1 B) on Bell and Spigot Dimensions for Cast Iron Pipe. Bulletin 87 reveals the results of tests made, under his direction, jointly for the Columbus Water Department, the Cast Iron Pipe Research Association and the Sectional Committee on Specification for C. I. Pipe and Castings.

Copies of Engineering Bulletin 87 can be purchased for 50 cents each from Ohio State University, Columbus, O.



Oliver Vacuum Filter Dewatering Sludge, Tannery Waste Treatment Plant, Rockford, Mich. Sludge of 94 Per Cent Water Content Reduced to 70 Per Cent Cake at Yield of 2.84 Lb./Sq. Ft.

TANNERY WASTE DISPOSAL AT ROCKFORD, MICH.

By G. E. HUBBELL*

Consulting Engineer, Detroit, Mich.

THE village of Rockford, Michigan, is located on the Rouge River fifteen miles north of Grand Rapids. The principal industry of the town is tanning and shoe making, which has continually created a waste disposal problem. The Rouge River has a minimum dry weather flow of 20 c.f.s. which is not sufficient for treatment by dilution of the average sewage flow amounting to 650,000 g.p.d. with a maximum hourly suspended solid content of 1,200 p.p.m. A financial solution to this problem was found in the Relief Program for Kent County which included a comprehensive clean up of all the rivers suffering from sewage pollution in the county.

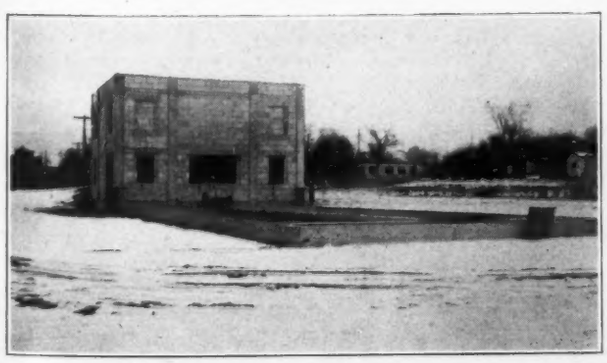
Design

The sewage flow treated varies over wide ranges. During the operation of the tannery the flow averages 1,500,000 g.p.d. dropping to 130,000 g.p.d. during shut downs. The problem is primarily one of tannery waste disposal. The sewage as it reaches the plant contains spent chemical waste, hide, hair, and fleshings. Its pH value is 9.0 and the five day B.O.D. is over 600 p.p.m. Complete treatment of the sewage was financially not possible and it was felt that plain sedimentation with adequate disposal of the sludge would do much to abate the nuisance in the river. Due to the location of the plant in the town and the large volume of solid matter to be handled which would require winter storage and sludge bed operation, it was decided that solid matter removed should be disposed of each day with no storage of sludge at the plant. This necessitated the use of continuous mechanical dewatering of the sludge and daily disposal of the filter cake on farm land.

A vacuum filter (5 ft. 4 in. diam. by 6 ft. in length) with an area of 100 sq. ft. was specified.

Sedimentation takes place in two tanks, 83 x 15 x 10 ft. average water depth, equipped with mechanical scrapers. The detention time is two hours for the maximum rate of 2,250,000 g.p.d. The design is standard, except that the inlets are of the submerged orifice type with special distribution structure in the tank, similar to the Dearborn type inlet as developed by the writer's firm.

*Hubbell, Hartgering and Roth, Inc., Engrs.



Waste Disposal Plant, Rockford, Mich., Treats 1.5 M.G.D. Sewage Flow of Which Better Than 90 Per Cent Is Waste from Tanning Industry

Construction and Cost

The entire plant was constructed by labor from relief rolls, and with local material in so far as possible. The finished structure combines simplicity of construction with pleasing appearance. The filter-house is of reinforced concrete beam and slab construction with exterior walls of precast cement blocks.

Total costs were as follows:

By: Village of Rockford	
Equipment and Engineering	$15,500
[Oliver-United filter, "Infilco" dry lime feeder, Link-Belt scrapers and American Monorail sludge hoist equipment]	
By: Relief	
[Labor and materials for 575 cu. yds. concrete, forms, sheeting for wet sand, cement blocks, misc. iron, and construction equipment, etc.]	38,000
Total	$53,500

Operation

The plant was put in operation in October, 1934. At first, when using 5.4 per cent lime (dry solid basis) for conditioning of sludge, a 70.0 per cent moisture cake was produced at the rate of 1.28 lbs. of dry solids per sq. ft. per hr. Later this rate was increased to 3.5 lbs. by the addition of 2 per cent ferric-chloride and an increase in the lime to 6.8 per cent. Modifications were then made in the mixing chamber and filter cloth with the result that the average rate of solids yield is now 2.84 lbs. when using 6.4 per cent lime for conditioning. The character of the tannery waste varies from day to day, as shown by the fact that for the same rates of lime added the filter rate varies from 2.13 lbs. to 3.68 lbs./sq. ft./hr. of dry solids.

The use of ferric-chloride would increase the above rate, but the cost of the ferric-chloride is greater than the cost to operate the filter for the additional time required because of the lower rate obtainable with lime alone. The plant operates on an eight hour basis with one operator in attendance. Detailed operating data and solids produced are as follows:

Conditioner—lime, 6.4% (dry basis)
Wet sludge to press, 6% solids
Sludge from press, 7,600 lbs. (30% solids)

Current 8 hrs. at 25c	$2.00
Lime, 150 lbs. at .5c	.75
Labor, 8 hrs at 45c	3.60
Yield: 2,280 lbs. dry solids at cost	$6.35
At cost per lb. of	0.28

The compactness of this plant is appreciated when it is realized that the plant handles the sludge load equivalent to that of an average city of 30,000 people. The plant performance has shown that it is practical to dewater undigested tannery waste sludge on a vacuum filter and that the resulting filter cake can be disposed of without nuisance. The sludge produced, containing lime and organic material, is a good soil builder and is readily disposed of on adjacent farm land. The plant was designed by Williams & Work, Civil Engineers and Surveyors, with Hubbell, Hartgering and Roth, Inc., as consultants.

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Earl Devendorf Appointed on WPA Staff

Earl Devendorf, associate director of the Division of Sanitation, New York, State Department of Health, was assigned by the State Commissioner of Health on August 10th to act as state consultant on sanitation, projects division, of the Works Progress Administration. The appointment was made at the request of the State Administrator of the WPA.

As consultant, Mr. Devendorf will pass upon the technical aspects of all WPA sanitary projects, including water supply and sewerage construction, submitted from communities in upstate New York. He will act also as liaison officer between the WPA and the local municipal officials in connection with such projects.

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Penna. Water Works Association Convention Oct. 16th-18th

The Pennsylvania Water Works Association will hold its Annual Convention on October 16th, 17 and 18th at Haddon Hall, Atlantic City, N. J.

The regular business meeting will be held on Wednesday afternoon, which will be followed by President Murdoch's address, a discussion on Financing an Operating Water Company, and an analysis of the Pennsylvania Public Service Commission's Seventeen Principles. Other topics scheduled for presentation by men prominent in their various fields are: Insurance, Determination of Fair Rate of Return, Taxation of Water Companies, Economic Situation of Water Companies, Pennsylvania Commission and Court Decisions During Past Year, and Recent Developments of Constitutional Law and Economics.

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Association Meetings Scheduled:

Sept. 17-20—**New England Water Works Association.** 54th Annual Convention. Providence-Biltmore Hotel, Providence, R. I. Sec'y. F. J. Gifford, 613 Statler Building, Boston, Mass.

Oct. 2-3—**Ohio Conference on Sewage Treatment.** Hotel Statler, Cleveland, O. Sec'y.-Treas. A. H. Fretter, Supt., Sewage Treatment Works, Medina, Ohio.

Oct. 3-4—**Ohio Conference on Water Purification.** Hotel Statler, Cleveland, Ohio. Sec'y.-Treas. W. B. Lockhart, Supt., Water Works and Sewage Treatment, Fostoria, Ohio.

Oct. 4-5—**New York State Sewage Works Association.** Hotel Van Curler, Schenectady, N. Y. Sec'y. A. S. Bedell, State Department of Health, Albany, N. Y. (Joint meeting with New England Sewage Works Association.)

Oct. 4-5—**New England Sewage Works Association.** Hotel Van Curler, Schenectady, N. Y. Sec'y. F. W. Gilcreas, State Department of Health, Albany, N. Y. (Joint meeting with New York State Sewage Works Association.)

Oct. 4-5—**North Dakota Water and Sewage Works Conference.** Grand Forks, N. D. Sec'y.-Treas. M. D. Hollis, State Sanitary Engineer, Bismarck, N. D.

Oct. 7-10—**American Public Health Association.** (64th Annual Meeting.) Hotel Schroeder, Milwaukee, Wis. Asst. Sec'y. W. R. Walsh, care A. P. H. A., Rockefeller Center, New York City.

Oct. 14-17—**Southwest Section, A. W. W. A.*** Houston, Texas. Sec'y. Lewis A. Quigley, Supt., Water Works, Fort Worth Texas. (*Former Southwest Water Works Assn.)

Oct. 14-15—**American Society Municipal Engineers and International Association Public Works Officials.** Netherland Plaza Hotel, Cincinnati, Ohio. Executive-Director, D. C. Stone, 850 East 58th Street, Chicago, Ill.

Oct. 16-18—**Penna. Water Works Association.** Annual Convention, Hotel Haddon Hall, Atlantic City, N. J. Secretary, F. Herbert Snow, Telegraph Building, Harrisburg, Penna.

Oct. 17-18—**New York Section A. W. W. A.** Hotel Powers, Rochester, N. Y. Sec'y. R. K. Blanchard, Neptune Meter Co., 50 West 50th Street, New York City.

Oct. 18-19—**Minnesota Section A. W. W. A.** Lowry Hotel, St. Paul, Minn. Sec'y.-Treas. R. M. Finch, care Wallace and Tiernan Co., 416 Flour Exchange Bldg., Minneapolis, Minn.

Oct. 23-26—**California Section A. W. W. A.** San Diego, Calif. Sec'y. J. E. Phillips, Department of Water and Power, Los Angeles, Calif.

Oct. 25-26—**Central States Sewage Works Association.** (Annual Meeting.) Urbana-Champaign, Ill. Sec'y.-Treas. G. H. Radebaugh, Urbana-Champaign, Ill.

Nov. 4-6—**North Carolina Section A. W. W. A.** Durham, N. C. M. F. Trice, State Board of Health, Raleigh, N. C.

Nov. 6-8—**Missouri Valley Section A. W. W. A.** Fort Des Moines, Ia. Sec'y.-Treas. Earl L. Waterman, Prof., Sanitary Engineering, University of Iowa, Iowa City, Ia.

Nov. 7-8—**Virginia Section A. W. W. A.** Hotel Roanoke, Roanoke, Va. Sec'y. H. W. Snidow, State Department of Health, Richmond, Va.

June 8-12, 1936—**American Water Works Association.** Annual Convention. Biltmore Hotel, Los Angeles, Cal. Sec'y. B. C. Little, 29 West 39th Street, New York City.

INCLINED DIAGONAL PIPE RUNS

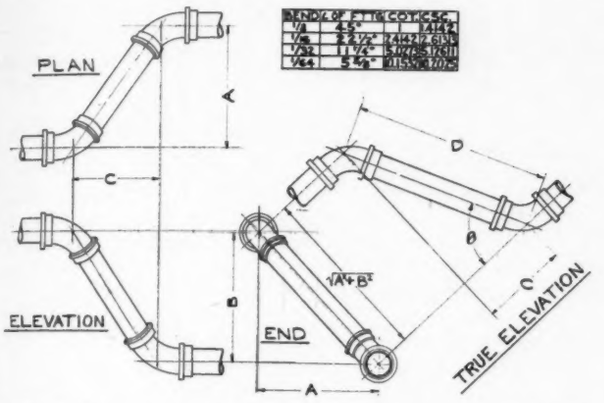
By CHARLES FRICK
Darby, Pa.

WATER words men may find the following formulas interesting and helpful in figuring lengths of pipe and tie rods on inclined diagonal runs.

The formulas are also useful in finding the approximate angle of fitting, theta (Θ), required (when bell and spigot pipe and fittings are used) when the dimensions in three planes have been decided upon.

The evolution of the formulas (see illustration) are also given in case the principle of revolution to a vertical plane may have further advantages in similar problems.

The subtraction of the center to end of spigot and center to back of bell taken from D gives the true length of pipe required.



Sketch Explanatory of Formulas for Lengths of Pipe for Diagonal Runs and Angle of Fittings

A.—When measurements in three planes are known, then

$$D = \sqrt{A^2 + B^2 + C^2} \qquad \text{Formula I}$$

$$L\Theta^{\cdot\tan} = \frac{\sqrt{A^2 + B^2}}{C} \qquad \text{Formula II}$$

Example: Let A = 5′6″, B = 3′0″, C = 14′9″
Find Θ and length of pipe required on 8″ line.

$$D = \sqrt{(5.5)^2 + (3)^2 + (14.75)^2}$$
$$= \sqrt{30.25 + 9 + 217.56} = 16.025' \text{ say } 16'0''$$

$$L\Theta^{\cdot\tan} = \frac{\sqrt{(5.5)^2 + (3)^2}}{14.75} = \frac{\sqrt{30.25 + 9}}{14.75}$$
$$= \frac{\sqrt{39.25}}{14.75} = \frac{6.265}{14.75} = 0.42474$$

$L\Theta = 23° +$ and a one-sixteenth curve may be used.

Length of pipe = D — (C to E of S. + C to B of B.)
= 16′0″ — (2′1″+) = 13′11″—

B.—When measurements in two planes are known and angle of fitting Θ decided upon, then

$$D = \sqrt{A^2 + B^2} \times \text{Csc } \Theta \qquad \text{Formula III}$$

$$C = \sqrt{A^2 + B^2} \times \text{Cot } \Theta \qquad \text{Formula IV}$$

Example: Let A = 8′0″, B = 9′6″, Θ = 45°
Find—C and length of pipe required on 12″ line.

$$D = \sqrt{(8)^2 + (9.5)^2} \times \text{Csc } 45°$$
$$= \sqrt{64 + 90.25} \times 1.4142$$
$$= 17.56' = 17'6\tfrac{3}{4}''$$

Length of pipe = D — (C to E of S. + C to B of B.)
= 17′6¾″ — (2′1⅞″) = 15′4⅞″

$$C = \sqrt{(8)^2 + (9.5)^2} \times \text{Cot } 45°$$
$$= \sqrt{64 = 90.25} \times 1$$
$$= 12.42 \times 1 = 12.42' = 12'5''$$

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A Sand Rise Indicator

An easily made, serviceable instrument for measuring sand levels in filters to determine expansion when washing, has been devised and built by Mr. C. F. Bingham, Superintendent Richmond Filtration Plant, and Mr. R. T. Homewood, Assistant Engineer Virginia State Department of Health.

The indicator consists of a 9 ft. piece of 1¼ inch copper tubing, graduated in inches, split in three sections (for convenience) and having a few appendages.

Attached to the lower end of this tube is a short piece of copper tubing, just large enough to hold a flash-light. The top of this flash-light compartment is soldered shut with a copper disc. To the bottom end of each tube is soldered a threaded sleeve coupling. Threaded caps to fit these couplings are drilled and fitted with glass windows, and the caps are so gasketed as to make the bottom of each tube watertight.

By lowering the instrument into the filter being washed, the exact location of the expanded sand surface can be determined—the lighted field viewed through the long tube disappears as soon as the sand level is reached. Any convenient point can be used as reference in reading the graduations at this point, and the same reference point used in reading the graduations for normal sand level; the difference in readings gives inches of expansion.

By inverting the instrument and pushing the tube through the unexpanded sand until the gravel is touched, the sand-depth can be determined. With these two figures the percentage expansion can be computed.

For convenience the tube can be cut into three or more lengths, and sleeve or screwed joints provided. The instrument has proved very useful in obtaining expansion data on filter plants in Virginia.

EDITORIAL

Needed—More Members

IT seems peculiar that an association which has served a field the length of time that the American Water Works Association has should have progressed so meagerly.

It is a sad commentary on the water works profession, that 54 years after the founding of a national association to serve so important an industry as that of water supply, that there are now but 2,800 members supporting the association, from a field served by upwards of 10,000 water works. When it is realized that a fair percentage of this 2,800 membership is comprised of consulting engineers, manufacturers, and their representatives, industrial engineers, and chemists, health department engineers, and foreign members, representation in the form of actual water works operating personnel is deplorably small. Realization of the necessity of doing something about such a situation a few years ago, led the executive board of the association to establish a special New Membership Committee under Arthur E. Gorman. A fund was appropriated to cover the cost of a campaign to bring before prospective members the value of A. W. W. A., and membership therein. The success of the undertaking passed expectations and proved more than self-supporting.

Why the program was discontinued during the several years that have intervened is not clear, but realizing the need for renewed efforts to bring forcibly to the attention of water works men the value of membership in A. W. W. A., a Committee on Increasing Membership was established this year under Chas. H. Eastwood as chairman. The success of the efforts were such as to warrant their continuance, with an increased appropriation. The drive just prior to the last annual convention of the association resulted in a satisfactory membership increase quantitatively, but in quality the yield lacked somewhat in desired attainments. Numbers were satisfactory, but actual operating men were too noticeably in the minority.

The problem before Mr. Eastwood, and his committee, is that of how most effectively to reach managers, superintendents and other water works operating personnel. How to prove to such men, who can benefit most from the work and activities of A. W. W. A., that the expenditure of $10.00 per year for membership (including 12 monthly issues of the Journal of A. W. W. A.) should be considered likewise a duty to their profession by way of support of the association. This much, even though they may not properly evaluate the personal gain from membership, or appraise the Journal at its true worth. To effectually attain this goal much more can be accomplished by personal contact than by a mailing campaign. The question is, can the association and its Committee on Increasing Membership gain the help of the many needed individual members by influencing each to bring before non-member neighbors and associates the value of membership, based on the "sales-story" prepared by the committee for the association's use? In answer, to this important question, lies the answer to the success of the avowed efforts of A. W. W. A. to grow; to expand its activities, and to be of the greatest possible value to every member.

President of A. W. W. A., Frank A. Barbour, in addition to being an engineer of repute, has attainments and a record as a business executive. Before the recent meeting of the Central States Section of A. W. W. A. (as reported elsewhere in this issue) he emphasized the greatest first need of the association—*more members*. The existing shamefully low membership of 2,800, out of a certain potential 5,000 membership from a field served by 10,000 water works, he felt to be inexcusable. Mr. Barbour named the important current activities and committee work of the association but stressed the point that a program of needed additional activities could only be executed with the availability of required funds. The most natural and equitable manner of getting funds was through membership dues and the way to go about that was more members and thereby distribution of the expense more widely over the field served. Mr. Barbour, a past-president of the New England Water Works Association, a director in the American Society of Civil Engineers and American Society of Testing Materials, has had experience of the sort to justify careful attention to his policies, arguments and proposals in association work.

Aside from the technical, there are other activities which A. W. W. A. should and could undertake. One is that of procuring a greater appreciation for the water works utility at large, the standing and security of water works personnel; and, improved situations for both. Mr. Barbour struck a responsive and keynote chord when he advanced the idea that A. W. W. A., with requisite funds, could and should undertake a program (at some expense of course) aimed at selling communities on the true and unseen values of their local water works utility and its operating personnel.

Here is another example of a possible worthy service which A. W. W. A. might perform for the water supply industry. In discussing power rates charged pumping stations, S. A. Canariis, in speaking before the Central States Section of A. W. W. A. (recorded on another page of this issue) considered depression proof water utilities, running 24 hours daily, to be the most dependable and constant of practically all users of power. He felt the practice of forcing pumping stations to stand a power demand charge was unjust and objectionable. He suggested that A. W. W. A. would be undertaking a valued and justifiable service in instigating and sponsoring a movement toward getting these unjust demand charges materially modified, if not completely eliminated.

These types of suggested or contemplated activity by A. W. W. A. justifies a greater number of corporate memberships and therefrom support from water departments, commissions and water companies in order that the association might carry on in their collective interest. Corporate membership also carries with it the privilege of one individual (personal) membership, without extra dues therefor. Such membership, carried in the name of the municipality and its superintendent or commissioner, while constituting a duty of the corporation, is, none the less, an investment of certain and profitable yield.

If this editorialization reaches the eye of some reader who believes sufficiently in the needs of A. W. W. A.; and, in turn, the potential added value which A. W. W. A. can give its members, to justify his efforts to "sell" A. W. W. A. to his neighbor or associate, a worth while end will have been attained. Personal contact and influence is what is most needed to build up A. W. W. A. Will you do your part in the "Every Member, a New Member" campaign? If so, just watch A. W. W. A. grow.

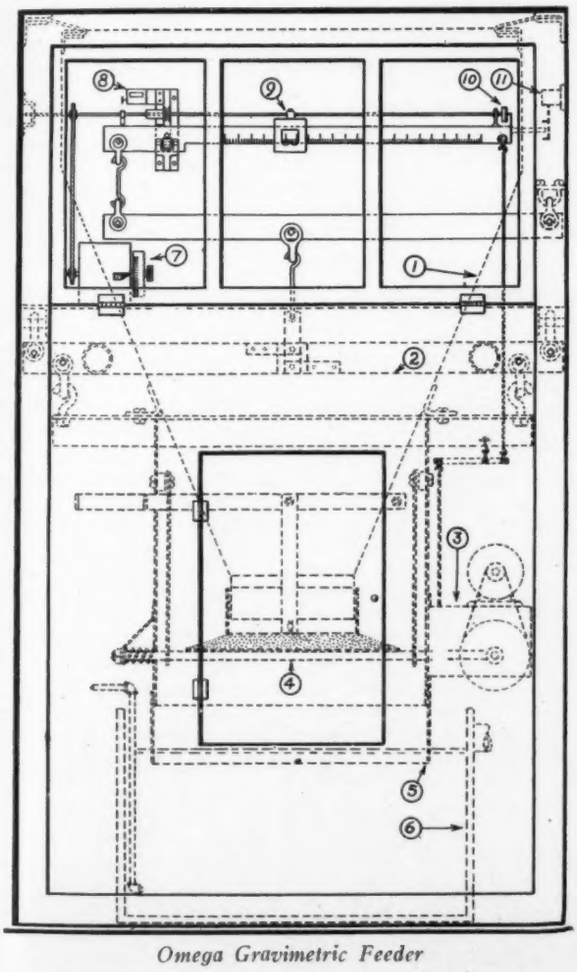
NEW EQUIPMENT AND LITERATURE

Omega Gravametric Dry Feeder

Omega Machine Company of Kansas City, Mo., has just placed on the market the Omega Gravametric Feeder which has, as its name implies, the distinctive feature of accurately feeding dry chemicals *by weight*, rather than volume. Unlike types of feeders commonly in use, which require recalibration of the feed control when changing to materials of greater or less density, the improved Omega does not. Setting the graduated control dial at the desired weight per hour insures uniform and accurate pounds per million dosage continuously, and regardless of how frequently the type of material being fed may be changed.

The time tested principle of feeding and dissolving the chemical, employed with the volumetric type of Omega feeders, has been retained. The new Omega Gravametric Feeder has been made subject to manual and automatic proportional feed operation. With the Omega Shadow Control Mechanism accuracy is guaranteed to be within 1 to 1/10th per cent variations, and a totalizer registers the weight of material fed out of the hopper during intervals between fillings. An alarm warns of empty hopper or any variation from the selected rate of feeding. Any dry material passing a 1-inch screen (and finer) can be fed and the machine comes equipped with the Omega Jet Type Dust Ejector to circumvent dust escape during hopper fillings. The new feeders are available in standard sizes to feed from 1 pound to 2 tons per hour, with hopper capacities from 500 pounds to 5 tons.

A clearer illustrated description of this interesting and novel feeder may be had by addressing—Omega Machine Company, 602 Westport Ave., Kansas City, Mo.



Omega Gravimetric Feeder

"Rust-Eeter" Makes Rust Stop Rust (A Novel Paint)

The protection of iron and steel surfaces against the destructive action of oxidation, by turning to use the oxide coating itself, is a new and interesting development in the paint field. In this the rusted surface itself becomes a protective part of the coating and therefore rust removal, involving expense and time, is not required. In fact rust removal is not desired when applying the new form of protective coating, known as "RUST-EETER."

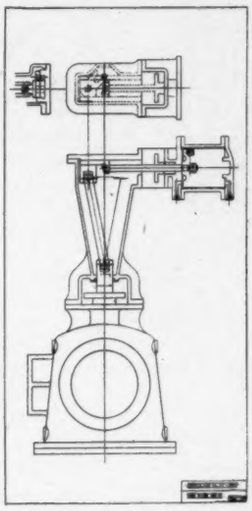
This novel protective coating has several unique properties. It is alkali and acid proof and produces a dense, tough and adhesive film which improves in protective qualities when alternately or continuously exposed to water and weathering. It is said to be equally resistant to attack by salt water and acidic or alkaline solutions or corrosive fumes. It is non-flammable and may be applied either by brush or spray-gun in order to reach the hard-to-get-at places. One gallon is claimed sufficient to cover 360 to 400 square feet of surface and dries completely in 24 hours. After three years of service "RUST-EETER" and "CLO-RUBBER" have been shown to be as protective as when first applied, is a statement by the manufacturers. "CLO-RUBBER" comes in standards colors and may also be used on concrete.

The fact that these protective coatings, which are made from a chlorinated rubber base, actually appears to "digest" and make use of rust coatings to which they are applied, is a claim of high importance to water works and sewerage operators. Its resistance to chlorine, hydrogen, sulphide and chemical solutions is of equal interest.

For further information address Harrington Paint Company, 1630 Collamer Ave. Cleveland, Ohio.

Anderson Thru-Flow Cone Valve

The Anderson Valve Corporation of Pittsburgh, Pa., has developed a radically improved Cone-Valve of the full opening Thru - Flow type.



Anderson Thru-Flow Cone Valve

Improvements involve the elimination of springs and a material number of parts from the Anderson patented operating mechanism, which is sealed in an oil filled steel housing. This new design should result in a longer life for the mechanism and freedom from repairs. At the same time the valve operation, by becoming simplified, has been made more positive in action and free of likelihood of failures.

The valve consists of a plug type cock with a patented control feature which forces the plug cock to become axially unseated before *its* 90 *degree* opening rotation, and also postively reseated *after* closing. Thereby friction is eliminated during the operation from closed-to-open-to-closed positions. In six sizes (starting with the 6 inch size) the improved and simplified Anderson Thru-Flow Cone Valves are available for automatic or manual control and can be had in hydraulically or electrically operated design.

For descriptive literature and records of service,—address—Anderson Valve Corporation, Koppers Building, Pittsburgh, Pa.

Announcing Byers Steel Pipe

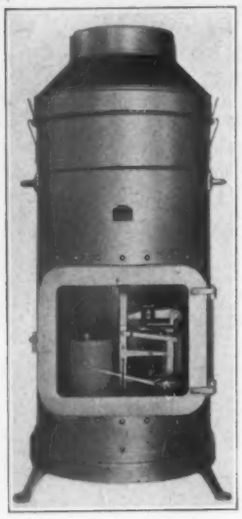
In addition to the well known Byers Wrought Iron Pipe, A. M. Byers Company have announced their entry into the steel pipe market. The decision to produce steel pipe marks the third major expansion of this well known firm which since 1864 have been one of the leaders in the wrought iron pipe industry.

Byers Steel Pipe is being manufactured under the same executive supervision that exists in the production of Byers Wrought Iron Pipe, and thus makes possible the recommendation and supplying of either product as the case may justify, or specifications demand.

For more complete information, address A. M. Byers Company, Clark Building, Pittsburgh, Pa.

Improved Fergusson Rain Gages

A new model of the Fergusson Weighing and Recording Rain and Snow Gage has just been announced by Julien P. Friez & Sons., Inc., of Baltimore, Maryland, well known manufacturers of standard meteorological and hydrometric equipment.



Fergusson Rain Gage

Precipitation is delivered through a collector ring of known area to a receiver resting upon a spring balance. This weighing mechanism is extremely sensitive. One hundredth of an inch of rainfall, snow or sleet is sufficient to depress the balance and register on the record chart. The record cylinder is revolved (daily or weekly), by a jeweled clock movement. The unique linkage from the weighing mechanism to the pen arm allows an extremely open scale on a relatively narrow chart.

This model, with capacities up to 12 inches of precipitation and more, has a distinct application where heavy rainfall in short periods is experienced or where an accurate record wtih minimum of attention is of especial value.

For literature descriptive of the new Fergusson gage and other types, address—Julien P. Friez & Sons, Inc., Central Ave., at Baltimore Street, Baltimore, Md.

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"Ayrgo" Material Cart

A modern cart for handling liquid or dry materials has recently been placed on the market by Pittsburgh-Des Moines Steel Company of Pittsburgh, Pa., and Des Moines, Ia.

Because of pneumatic tires, Timken roller bearings and full control handles their modern cart has been named "AYRGO" and pronounced "air-go." Ease of handling makes practicable its increased capacity for transporting greater loads per man-trip than has been heretofore attainable.

Ayrgo Cart

The cart body is of the electric-welded steel sheets, has a liquid volume of 11 cu. ft. and will handle a 1900 pound load. The cart complete weighs but 260 pounds, stands 30 inches high and is designed for scooping up partial loads of bulk cement, etc.—thus reducing hand shoveling. It will handle the complete discharge of a No. 10-S mixer.

P. S.—The tires are of an odd size to prevent theft for use on automobiles.

For additional information address—Pittsburgh-Des Moines Steel Co., Neville Island, Pittsburgh, Pa., or the Des Moines, Ia., plant.

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Roots-Connersville Turbine Pumps

Roots-Connersville Blower Corporation has recently announced that their line of Type "T" Turbine Pumps, which combines the rotary positive and centrifugal pump advantages, has been expanded to serve the water-works as well as the industrial fields. These pumps, however, are especially suited to handling 5 to 300 G.P.M. output against high heads (up to 500 ft.). This range is covered in standard sizes.

The company has recently announced the transfer of J. T. Sutliff from the factory to their Chicago offices at 20 No. Wacker Drive where he will specialize on sales of Type T. Turbine Pumps and Victor-Acme Air Blowers which are built on the rotary positive principle, pioneered by Roots-Connersville.

For descriptive bulletins address Roots-Connersville Corporation, Connersville, Ind., or J. T. Sutliff at the Chicago address above.

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Catalogs and Trade Literature Received

"Building Good Will"—Is the unseen title of a little illustrated leaflet recently supplied gratis, by the Ford Meter Box Company of Wabash, Ind., to its customers. These were designed for sending out to water consumers by Water Departments, along with their bills. The actual title on the cover that reaches the customer's eye is, "How Would *YOU* Like to be Without *IT?* The leaflet is designed and illustrated for quick and easy reading, in hopes that a better understanding of what's behind the water utility may be given the consumer who thinks little beyond the faucet and the cashier's window in the water office. The favorable comments, by Ford's customers, on the value of these leaflets has led them to offer to supply any others interested with leaflets at the actual cost of printing—$2.50 per 1000 copies. For a sample copy, address—Ford Meter Box Co., Wabash, Indiana.

"Zeolites"—A booklet of this title describes the mining and processing of greensand zeolite, the manufacture of synthetic zeolites, and the characteristics and uses of the two distinctive types. Also an improved (new) greensand zeolite is described which has about double the capacity of ordinary greensand zeolite; moreover, retaining the desirable properties of greensand. Applications of zeolitic softening in the municipal and industrial fields are briefly outlined and the booklet is copiously illustrated. The booklet is essentially a reprinted paper delivered by Eskel Nordell, Chemical Engineer of The Permutit Company, before the Michigan Conference on Water Purification. For a copy, address The Permutit Co., 330 West 42nd Street, New York City.

Liquid Chlorine—A folder from Pennsylvania Salt Mfg. Co., contains pertinent physical-chemical data on liquid and gaseous chlorine and a description of the various types of containers, tank-cars and valves used in its shipment. Constitutes a handy reference for the file of engineers and operators. Ask for "Liquid Chlorine"—address Pennsylvania Salt Mfg. Co., Widener Bldg., Philadelphia, Pa.

"Quimby Rubber Lined Pumps"—A new bulletin which describes and illustrates centrifugal pumps with linings and impeller coatings of resilient rubber, more resistant to damage than are hard rubber lined pumps. Quimby-Doty Pumps, which have been in use by the chemical industry for several years are of interest to those faced with the problem of pumping ferric chlorine, chlorinated copperas or other corrosive liquids. Ask for bulletin C-112. Address—Quimby Pump Company, 340 Thomas Street, Newark, New Jersey.

"Non Sparking Tools"—Those interested in avoiding the hazard of sparks flying from steel tools, and resulting in explosions at sewage plants and on sewers, will find the brochure on "Stanley Non Sparking Tools" (made of the new hard Berryllium-Copper alloy) worthy of note. Technical data, descriptions, illustrations and prices of the complete line of these safety tools are included. For a copy, address Stanley Tools, New Britain, Conn., or American Brass Co., 25 Broadway, New York City.

"Self-Vulc"—A 12-page booklet describes "Self-Vulc" Plastic Rubber and "Air-Vulc" Liquid Rubber, which are materials prepared for application by the purchaser for acid-proofing, corrosion-proofing, and water-proofing metal or other surfaces. Wherever a rubber covering will prove advantageous these compounds can be handled like paint and brushed on, sprayed on or dipped on. Being 90 per cent pure gum it serves as an insulating material. It does not become brittle in sub zero temperatures and is unaffected by heat up to 200 deg. F. For a copy of this booklet, address Self-Vulcanizing Rubber Co., 615 W. Washington Blvd., Chicago, Ill.

Protective Rubber Linings — Is the title of a booklet descriptive of rubber lined tanks and rubber coated equipment produced by Manhattan Rubber for use in storing and handling corrosive solutions such as ferric-chlorine and the like. For a copy address Manhattan Rubber Mfg. Division, Raybestos-Manhattan, Inc., Passaic. N. J.

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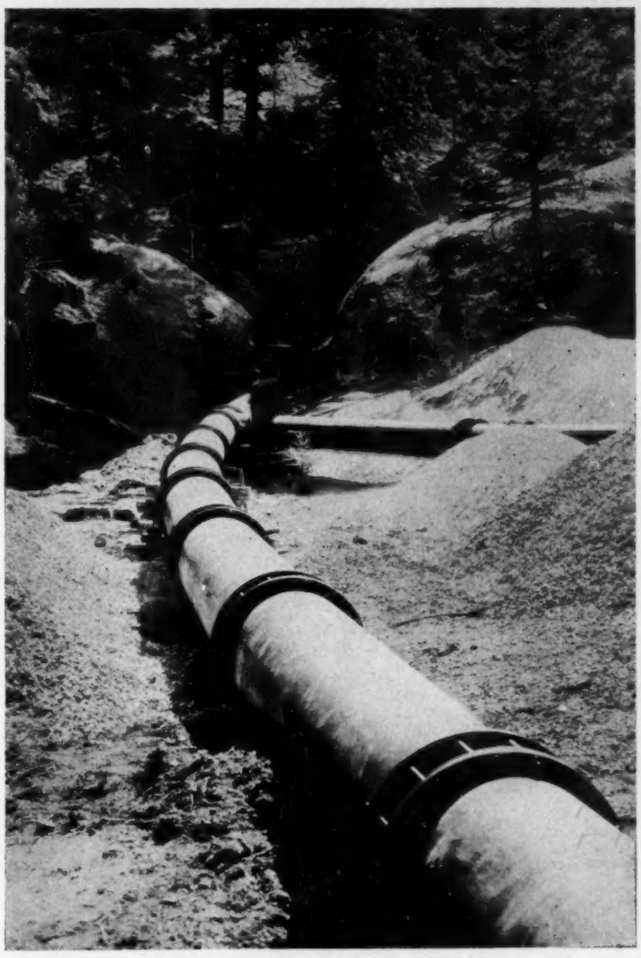

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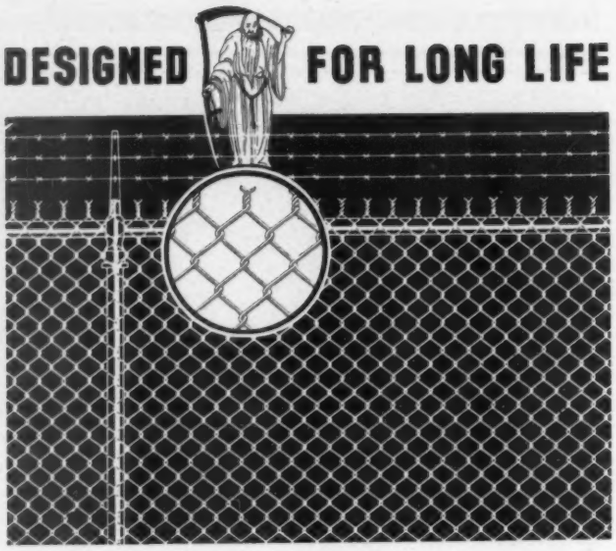

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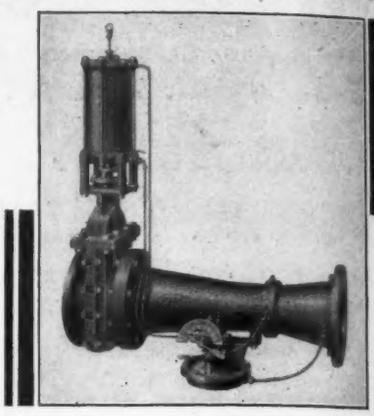

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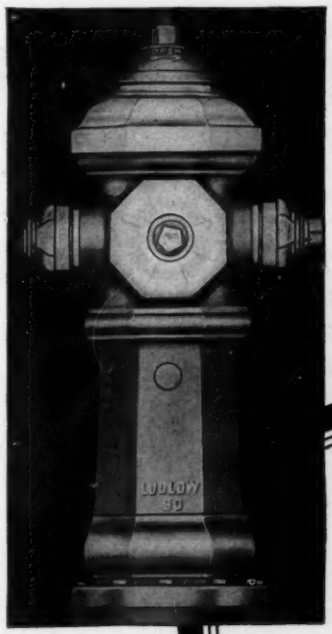

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On other pages in this issue you will find described new and improved equipment, etc., as well as reviews of recent trade literature received by us. By requesting the literature described you will be able to keep your catalog file complete and up to date.

To our readers desiring additional help or information we will be glad to assist you in securing more complete information or data on any equipment or product you need. Use the convenient blank below—No cost or obligation.

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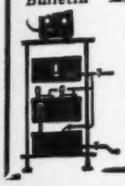

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By Frank L. LaMotte, William R. Kenny, Allen B. Reed

TABLE OF CONTENTS

Section A. Mechanism of Hydrogen Ion Determinations
I—Introduction and Preliminary Discussion
II—Hydrogen and Hydroxyl Ions
III—Buffer Action
IV—Determination of pH
V—Sources of Error
Section B. Practical Application of Hydrogen Ion Determinations in Industry and Science
VI—Municipal and Industrial Water Supply
VII—Water Corrosion Problems
VIII—Disposal of Sewage and Industrial Waste
IX—Sugar Industry
X—Gelatin and Glue
XI—Leather Manufacture
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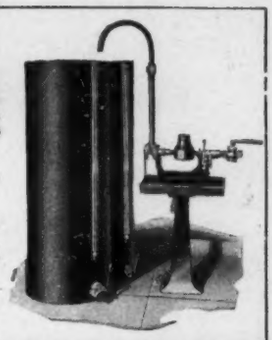

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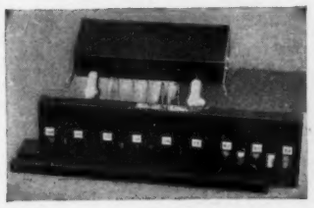

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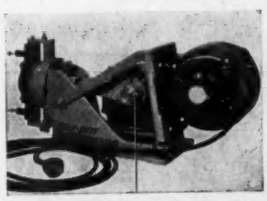

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ADVERTISERS IN THIS ISSUE

A

Alvord, Burdick & Howson 67
American Brass Co., The 15
American Cast Iron Pipe Co. 66
Anaconda Amer. Brass, Ltd. 15
Arrowhead Iron Works 18
Atlas Mineral Products Co. of Pa., The 11

B

Barrett, Haentjens & Co. 5
Bellevue Stratford Hotel 64
Black and Veatch 67
Builders Iron Foundry 65
Burns & McDonnell Engr. Co. 67

C

Carborundum Company, The 9
Cast Iron Pipe Research Asso., The 22
Chain Belt Company 6
Chester Engrs., The J. N. 67
Chicago Pump Company 17
Chicago Testing Laboratory, Inc. 67
Cole Manufacturing Co., R. D. 18
Columbian Iron Works 12
Cooper-Bessemer Corp., The 4
Crane Company 8

D

Dorr Company ..... Third Cover
Dracco Corp. 16
Dresser Mfg. Co., S. R. 63

E

Edson Corporation, The 66
Electro Bleaching Gas Co. 21
Everson Filter Co. 67

F

Filchor Company, The 67
Ford Meter Box Co. 69
Fuller & McClintock 67

G

Gillette Publishing Company 68
Great Western Electro-Chemical Co. 63

H

Hellige, Inc. 69
Hill, Jr., Nicholas S. 67
Hudson Coal Co., The 65
Hydraulic Development Corporation 17

I

Industrial Chemical Sales Co., Inc. 7
International Filter Co. 64
Iron & Steel Products, Inc. 68

K

Knowles, Inc., Morris 67

L

LaMotte Chemical Products Co. 66
Lock Joint Pipe Co. 69
Ludlow Valve Mfg. Co., The 65
Lynchburg Foundry Company 19

M

Mathieson Alkali Works, Inc., The 20
Metcalf & Eddy 67
Mueller Company 12

N

National Water Main Cleaning Co. 19

O

Oliver United Filters, Inc. 13
Omega Machine Company, Inc. 69

P

Permutit Company, The 17
Phipps & Bird, Inc. 67
Pirnie, Malcolm 67
Pittsburgh Steel Co. 64
Portland Cement Association 10
Potter, Alexander 67
Powell, Shepard T. 67
Proportioneers, Inc. 69

R

Reading Iron Company 16
Roberts Filter Mfg. Co. 66
Royer Foundry & Machine Co. 16

S

Simplex Valve & Meter Co. 64
South Bend Foundry Co. 68

T

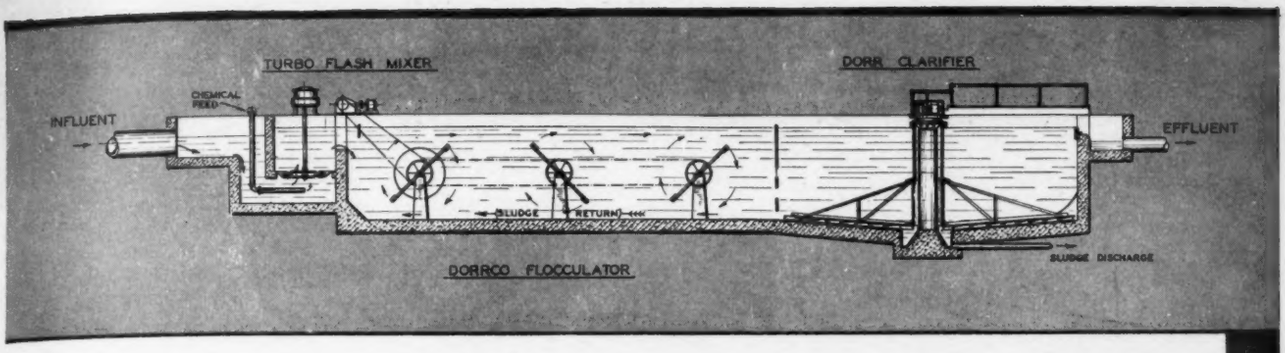
Taylor & Co., Inc., W. A. 69

U

United States Pipe & Foundry Co. ..... Second Cover

W

Wallace & Tiernan Co. ..... Back Cover
Warren-Knight Co. 68
Wentworth Hotel 69
Weston, L. A. 67
Whitman & Howard 67
Wilson, P. S. 67
Wood Co., R. D. 14



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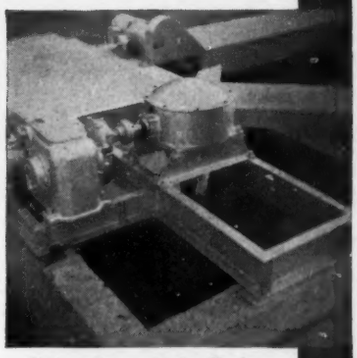

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DORRCO

Let our engineers show you how an installation like this is a self-liquidating investment that pays for itself out of savings.

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Zachary Taylor, *12th President of the U. S. A.*

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